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NATIONAL DAM SAFETY PROGRAM. LAKE WANDA DAM (NJ00510), HUDSON R--ETC(U)
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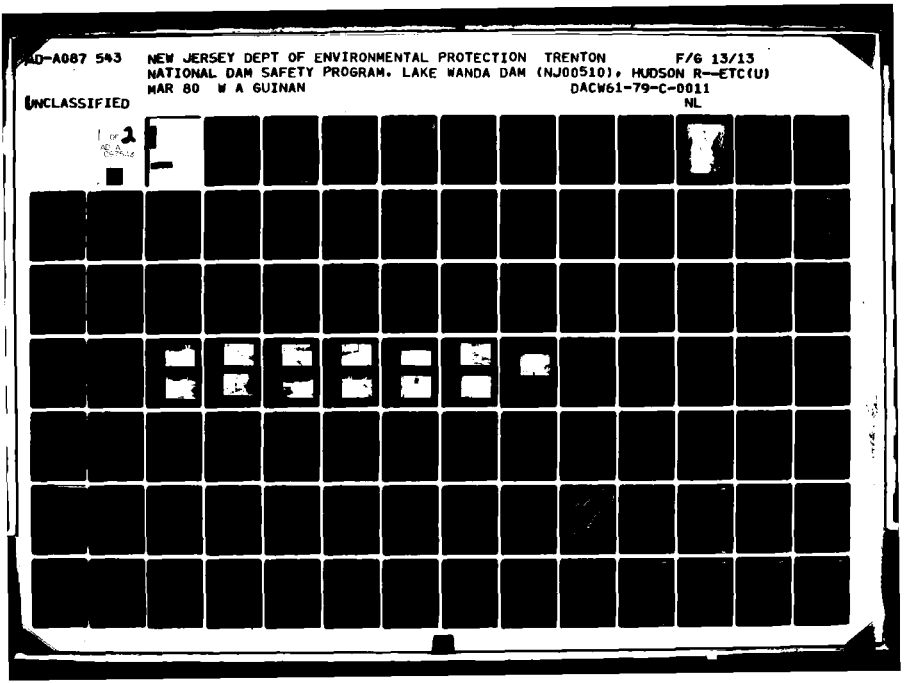

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Structural Analysis
National Dam Safety Program
Lake Wanda Dam, New Jersey
Seepage
Erosion

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106



IN REPLY REFER TO
NAPEN-N

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

28 JUL 1980

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Lake Wanda Dam in Sussex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Lake Wanda Dam, initially listed as a high hazard potential structure but reduced to a low hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's three spillways are considered inadequate because a flow equivalent to five percent of the One Hundred Year Flood would cause the dam to be overtopped. The low hazard potential classification means that in the event of failure of the dam, no loss of life and only minimal economic loss is expected. As the hazard potential classification could change with future development, it is recommended that the classification be reviewed periodically. To ensure the continued functioning of the dam and its impoundment, the following remedial actions could be undertaken by the owner:

a. Retain a professional engineer qualified in the design and construction of dams to accomplish the following:

(1) Evaluate the major seepages, steepness of the downstream slope, and sinkholes on the crest of the dam and design and implement appropriate remedial measures.

(2) Design and implement procedures to rebuild or replace the middle and north spillways with sufficient capacity to prevent overtopping.

(3) Specify and oversee procedures for the removal of trees and brush from the embankment and downstream toe of the dam.

(4) Design and install erosion protection for the upstream slope.

b. Clear debris from the discharge channels downstream of the three spillways.

NAPEN-N
Honorable Brendan T. Byrne

c. Remove the 30-inch pipes and the fill upstream of the stoplog spillway.

d. Rehabilitate or replace the low-level outlet pipe and operating mechanism.

e. Clear trees and brush from each side of the spillway discharge channels downstream of the three spillways.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

This report should prove of value to the dam's owner in that a format for future inspection is provided. Maintenance items, similar to the suggested remedial actions, will periodically develop, requiring attention by the owner.

Sincerely,

1 Incl
As stated

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

## LAKE WANDA DAM (NJ00510)

## CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 7 November 1979 by Anderson-Nichols & Company, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Lake Wanda Dam, initially listed as a high hazard potential structure but reduced to a low hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's three spillways are considered inadequate because a flow equivalent to five percent of the One Hundred Year Flood would cause the dam to be overtopped. The low hazard potential classification means that in the event of failure of the dam, no loss of life and only minimal economic loss is expected. As the hazard potential classification could change with future development, it is recommended that the classification be reviewed periodically. To ensure the continued functioning of the dam and its impoundment, the following remedial actions could be undertaken by the owner:

a. Retain a professional engineer qualified in the design and construction of dams to accomplish the following:

(1) Evaluate the major seepages, steepness of the downstream slope, and sinkholes on the crest of the dam and design and implement appropriate remedial measures.

(2) Design and implement procedures to rebuild or replace the middle and north spillways with sufficient capacity to prevent overtopping.

(3) Specify and oversee procedures for the removal of trees and brush from the embankment and downstream toe of the dam.

(4) Design and install erosion protection for the upstream slope.

b. Clear debris from the discharge channels downstream of the three spillways.

c. Remove the 30-inch pipes and the fill upstream of the stoplog spillway.

d. Rehabilitate or replace the low-level outlet pipe and operating mechanism.

e. Clear trees and brush from each side of the spillway discharge channels downstream of the three spillways.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 19 JUN 80

V

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

| | |
|---|---|
| Name of Dam: | Lake Wanda Dam |
| Identification No.: | FED ID No. NJ00510 |
| State Located: | New Jersey |
| County Located: | Sussex |
| Stream: | Tributary to Wawayanda Creek |
| River Basin: | Hudson |
| Date of Inspection: | November 7, 1979 |

## ASSESSMENT OF GENERAL CONDITIONS

Lake Wanda Dam is an old dam of undetermined age in poor condition. It is small in size and should be downgraded to low hazard from its initial classification of high hazard. The crest of the dam is a grassy footpath with large trees and brush growing on it. There are trees and brush on the upstream and downstream slopes of the dam and in the downstream toe areas. The three spillways are in very poor condition. The concrete at the left and middle spillways is badly cracked and broken. The concrete at the stoplog spillway is surface eroded. There are boulders on the north spillway crest and boulders, logs, and loose soil on the middle spillway crest. Erosion has occurred on the upstream slope at lake level. Large seepages are occurring along the toe of the dam. There is erosion of the soil bank on the north side of the discharge channel immediately downstream of the stoplog spillway. There are logs and debris in the discharge channel of the middle and north spillway. Trees and brush overhang all discharge channels. The three spillways can pass approximately 4 percent of the 100-year storm and are inadequate.

Lake Wanda Dam does not now pose a potential hazard to loss of life and only minimal property damage could occur if it should be breached. However, should the owner wish to maintain the integrity of the embankment he should retain the services of a professional engineer, qualified in the design and construction of dams to accomplish the following as specified. Starting soon: evaluate the major seepages, steepness of the downstream slope, and sinkholes on the crest of the dam and design and implement appropriate remedial measures. Design and implement procedures to rebuild or replace the middle and north spillways. In the near future: specify and oversee procedures for the removal of trees and brush from the embankment and downstream toe of the dam. Design and install erosion protection for the upstream slope. In the future: remove the 36-inch pipes and the fill upstream of the stoplog spillway, Rehabilitate or replace the low-level outlet pipe and operating mechanism.

It is further recommended that the owner accomplish the following tasks as a part of operating and maintenance procedures: starting

in the near future, clear debris from the discharge channels downstream of the three spillways. In the future, clear trees and brush from the sides of each spillway discharge channel downstream of the three spillways.

ANDERSON-NICHOLS & COMPANY, INC.

Warren A. Guinan

Warren A. Guinan, P.E.
Project Manager
New Jersey No. 16848

OVERVIEW
LAKE WANDA DAM

7 NOVEMBER 1979

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY REPORT

LAKE WANDA DAM N.J. NO. 22-154 FED NO. NJ00510

# PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION PROGRAM
LAKE WANDA DAM
FED ID NO. NJ00510 N.J. NO. 22-154

# SECTION 1
# PROJECT INFORMATION

## 1.1 General

a. Authority. Authority to perform the Phase I Safety Inspection of Lake Wanda Dam was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 26 October 1979 under Contract No. FPM-39 dated 28 June 1978. This authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the U.S. Army Engineers District, Philadelphia. The inspection discussed herein was performed by Anderson-Nichols & Company, Inc. on 7 November 1979.

b. Purpose. The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to the safety of Lake Wanda Dam and appurtenances based upon available data and visual inspection, and determine any need for emergency measures and conclude if additional studies, investigations, and analyses are necessary and warranted.

## 1.2 Project Description

a. Description of Dam and Appurtenances. Lake Wanda Dam is a 496 foot long earthfill dam with a hydraulic height of 5.6 feet and a structural height of 6.8 feet. The upstream face of the dam is of earth with a 5H:2V slope except for the far end of the right abutment which is of concrete with vertical slope. The downstream face is of earth with a 6H:7V slope. The crest of the dam is covered by trees and brush with a top width varying between 6.5 feet to 8.0 feet. A 10-foot long concrete free overflow spillway is located on the left (north) end of the dam (north spillway). A 16-foot long concrete free overflow spillway is located in the middle of the dam. Two 3-foot diameter pipes are located on the right (south) side of the dam 6 feet upstream of a 6-foot long stoplog opening. This stoplog section regulates the flow out of the two pipes. A 20-foot long low-level CMP pipe with a diameter of 15 inches is located below the middle spillway. Essential features of the dam are given in Figures 1 and 2.

b. Location. The dam is located in the town of Vernon, Sussex County, New Jersey on a tributary to Wawayanda Creek, approximately 11 miles south of Warwick, New York. It is at north latitude 41° 10.9' and west longitude 74° 27.1'. A location map is given in Figure 3.

c. Size Classification. Lake Wanda Dam is classified as being small in size on the basis of storage at the dam crest of 186 acre-feet, which is less than 1000 acre-feet but more than 50 acre-feet, and on the basis of its structural height of 6.8 feet, which is less than 40 feet, in accordance with criteria given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Visual inspection of the downstream area showed that failure of Lake Wanda Dam poses no hazard to life and that the possibility of property damage is remote. The lake drains into a swamp with an area equal or greater than the lake area. From the swamp the outlet channel continues through a broad flat area and into Wawayanda Lake, which is approximately 10 times as large as Lake Wanda. Lake Wanda Dam is accordingly classified as Low Hazard.

e. Ownership. According to officials of Vernon Township, Lake Wanda Dam is owned by Mr. Karl Schwarz, Box 13, Montville, New Jersey 07045. Mr. Schwarz's ownership was verified by a conversation with tow of the Lake Wanda residents. A letter was sent to the above address with no response. Mr. Schwarz's phone number is unlisted.

f. Purpose of Dam. The lake is used for recreation.

g. Design and Construction History. No information was revealed regarding the design and construction of the dam.

h. Normal Operational Procedures. No operational procedures were disclosed.

i. Site Geology. No site geologic information (such as borings) was available at the time the dam was inspected. Information derived from a Geologic Map of New Jersey (Lewis & Kummel, 1912) indicates that soils within the immediate site area consist of ground moraine overlying bedrock. Bedrock was observed in sporadic outcrops at the right side of the downstream channel during inspection of this dam. The previously mentioned map indicates that bedrock in this area consists of granitoid gneiss of Precambrian age.

## 1.3 Pertinent Data

a. Drainage area

Watershed - 3.48 square miles

Normal water surface - 31 acres

b. Discharge at damsite (cfs)

Maximum flood at damsite - unknown

Spillway capacity at top of dam

| | | |
|---|---|---|
| south spillway (stoplogs removed) | - | 112 |
| south spillway (with stoplogs) | - | 1 |
| north spillway | - | 23 |
| middle spillway | - | 4 |
| total spillway capacity | - | 28 |

Low-level outlet (if operable) at normal pool elevation - 19

c. Elevation (NGVD)

Top of dam - 1174.8'

Recreation pool - 1174.6'

Spillway crest - north spillway - 1173.9'
middle spillway - 1174.6'
stoplog spillway - top of stoplogs - 1174.7'
-bottom of stoplogs - 1172.7'

d. Reservoir (feet)

Length of maximum pool - 1540

Length of recreational pool - 1530

e. Storage (acre-feet)

Recreational pool - 160

Design surcharge - 298

Top of dam - 184

f. Reservoir Surface (acres)

Top of dam - 33

Recreational pool - 31

g. Dam

Type - earthfill with earthen and concrete upstream face

Length - 496 feet

Height - 5.6 (hydraulics)

6.8 (structural)

Top width - varies, 6.5 to 8 feet

Side slopes - dam: upstream - 5H:2V and vertical
downstream - 6H:7V and vertical

Zoning - concrete and earthfill upstream and earthfill downstream faces

impervious core - unknown

cutoff - unknown

grout curtain - unknown

h. Spillways

North Spillway -

Type - free overflow flat crested concrete capped

Length - 10 feet

Crest elevation - 1173.9' NGVD

Gates - none

Upstream channel - Lake Wanda

Downstream channel - tributary to Wawayanda Creek

Middle Spillway -

Type - free overflow flat crested concrete capped

Length - 16 feet

Crest elevation - 1174.6' NGVD

Gates - 15-inch low-level outlet

Upstream channel - Lake Wanda

Downstream channel - tributary to Wawayanda Creek

Stoplog (south) Spillway -

Type - concrete capped with wooden stoplogs

Length - 6 feet

Crest elevation - 1174.7' NGVD

Gates - stoplogs

Upstream channel - Lake Wanda

Downstream channel - tributary to Wawayanda Creek

i. Regulating Outlets

Type - one 15-inch diameter CMP low-level outlet

Length - 20'

Access - none found

Regulating facilities - not visible

## SECTION 2
## ENGINEERING DATA

### 2.1 Design

No plans, hydraulic or hydrologic data for Lake Wanda Dam were revealed.

### 2.2 Construction

No data concerning construction of Lake Wanda Dam were revealed.

### 2.3 Operation

No engineering operational data was unveiled.

### 2.4 Evaluation

a. Availability. A search of the New Jersey Department of Environmental Protection files revealed no recorded information. Attempts to contact the owner were unsuccessful.

b. Adequacy. Because of lack of available recorded data, evaluation of this dam was based solely on visual inspection.

SECTION 3
VISUAL INSPECTION

## 3.1 Findings

a. Dam. Large seepages, estimated to be in the range of 5-100 gallons per minute, are occurring at five locations along the toe of the dam (at 44 feet and 15 feet to the right, and at 60, 160, and 210 feet to the left of the middle spillway). In addition, there is standing water without evidence of flow at one location (120 feet to the left of the middle spillway). Debris has been dumped at the toe of the dam at one location (71 feet to the right of north spillway). The downstream slope of the dam is steep (6H:7V). On the crest of the dam there are three holes (4, 39, and 207 feet to the left of the middle spillway). At one location (21 feet to the right of the north spillway) the downstream edge of the crest is slightly lower than the upstream edge and major seepage is evidenced by the sound of running water heard beneath the crest. Trees and brush are growing on the upstream and downstream slopes of the dam and in the downstream toe area. There appears to be riprap on the upstream slope below the lake level, but there is no riprap at and above lake level. Some erosion has occurred on the upstream slope at lake level.

b. Appurtenant Structures. The level of the middle spillway appears to have been raised by placing logs, boulders, concrete and soil on the upstream side of the spillway crest. The spillway is poorly constructed and in very poor condition. The concrete is badly cracked and broken and there were no visible abutments to the concrete spillway. The concrete at the north spillway is badly cracked and broken. The abutments to this spillway are not defined and the approach channel is filled with rocks. The spillway at the right end of the dam has stoplogs which are backed up with pieces of plywood. The deterioration of the concrete is limited to surface erosion. There are two pipes in the approach channel to this spillway which restrict the flow to the stoplog facility.

c. Reservoir Area. The watershed above the lake is gently to moderately sloping; it is partly built up and partly wooded. There are many homes on the shore of the lake. The reservoir slopes appear to be stable. No evidence of significant sedimentation was observed.

d. Downstream Channel. The entire width of the valley downstream of the dam is low and swampy. At the spillway near the south end of the dam, there is some erosion of the soil bank on the north side of the discharge channel immediately downstream of the spillway, some trees and brush overhang the channel, and there are a few boards and some brush in the channel. At the spillway near the middle of the dam, there are some logs and debris in the discharge channel and trees and brushes overhang the channel. At the spillway at the north end of the dam, there are trees and brush growing in the discharge channel, there is some debris in the channel (lumber, logs, barrels), and trees overhang the channel.

# SECTION 4
# OPERATIONAL PROCEDURES

## 4.1 Procedures

No formal operating procedures were revealed.

## 4.2 Maintenance of Dam

No formal maintenance procedures for the dam were revealed.

## 4.3 Maintenance of Operating Facilities

No formal maintenance procedures for the operating facilities were revealed.

## 4.4 Warning System

No description of any warning system was found.

## 4.5 Evaluation of Operational Adequacy

Because of the lack of operational and maintenance procedures, the remedial measures described in Section 7.2 should be implemented as prescribed.

SECTION 5
HYDROLOGIC/HYDRAULIC

## 5.1 Evaluation of Features

a. Design Data. Because no data were revealed an evaluation could not be performed.

b. Experience Data. No experience data were found.

c. Visual Observation. No visual evidence was found of damage to the structure caused by overtopping. At the time of inspection approximately 0.7 foot of water was passing over the north spillway, 1 inch of water over the middle spillway, and 1 inch of water over the stoplog spillway.

d. Overtopping Potential. The hydrologic/hydraulic evaluation for Lake Wanda Dam is based on a selected spillway design flood (SDF) equal to a 100-year flood in accordance with the range of test floods given in the evaluation guidelines for dams classified as low hazard and small in size. The 100-year flood has been determined by application of the SCS dimensionless unit hydrograph procedure to a 12-hour 100-year storm of 6.2 inches. The routed 100-year flood peak discharge for the subject watershed is 949 cfs.

The minimum elevation of the dam allows 0.9 foot of depth in the north spillway, 0.2 foot in the middle spillway and 0.1 foot in the stoplog spillway before overtopping occurs. Under this head the total spillway capacity is 28 cfs, which is less than the selected SDF. Flood routing calculations indicate that Lake Wanda Dam will be overtopped for more than 10 hours to a maximum depth of 1.48 feet under 12 hour, 100-year storm conditions. It is estimated that the spillways can only pass about 4 percent of the 12 hour 100-year flood without allowing overtopping of the dam, thus the spillways are considered inadequate.

e. Drawdown Capability. Assuming that the low-level outlet currently in place can be restored to an operable condition, it is estimated that the lake can be drained in approximately 7.4 days assuming no significant inflow. Because Lake Wanda poses no hazard to life and the possibility of property damage is remote, this time period is considered adequate for draining the reservoir in an emergency condition.

## SECTION 6
## STRUCTURAL STABILITY

### 6.1 Visual Observations

Major seepage taking place through the dam could lead to piping and breaching of the dam at any time. The steepness of the downstream slope increases the probability that the seepage could lead to major problems. Holes on the crest of the dam indicate that serious internal erosion of the dam has already occurred. Trees and brush (which may grow to tree-size) on the upstream and downstream slope of the dam and in the downstream toe area can lead to further seepage and erosion problems if a tree blows over and pulls out its roots or if a tree dies or is cut and its roots rot. Erosion on the upstream slope of the dam could lead to breaching of the dam if not controlled. The deteriorated condition of the middle and north spillways and the lack of abutments could lead to breaching of the dam if left uncorrected. Based on the visual inspection alone, it is not possible to determine the character of the dam foundation or the interior of the cross section of the embankment. It is therefore not possible to evaluate the factor of safety of the dam against slope failure.

### 6.2 Design and Construction Data

No design or construction data pertinent to the structural stability of the dam are available.

### 6.3 Operating Records

No operating records pertinent to the structural stability of the dam are available.

### 6.4 Post-Construction Changes

No record of post-construction changes pertinent to the structural stability of the dam are available.

### 6.5 Seismic Stability

This dam is in Seismic Zone 1. According to the Recommended Guidelines, dams located in Seismic Zone 1 "may be assumed to present no hazard from earthquake provided static stability conditions are satisfactory and conventional safety margins exist." None of the visual observations made during the inspec- are indicative of unstable slopes. However, because no data are available concerning the engineering properties of the embankment and foundation materials for this dam, it is not possible to make a numerical evaluation of the factor of safety under static conditions.

SECTION 7
ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

## 7.1 Dam Assessment

a. Condition. Lake Wanda Dam is an old dam of undetermined age and is in poor condition.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based solely on the results of the visual inspection.

c. Urgency. Because the dam poses no hazard to life and little hazard to property there is little urgency to implement the recommendations in Sections 7.2 based on safety considerations. Should the owner wish to maintain the dam embankment the recommendations should be implemented as prescribed.

d. Necessity for Additional Data/Evaluation. The information available from the visual inspection is adequate to identify the potential problems which are listed in 7.2 a. below. These problems require the attention of a professional engineer qualified in the design and construction of dams who will have to make additional engineering studies to design or specify remedial measures. If left unattended, the problems could lead to failure of the dam. Because the dam is of low hazard no further hydrologic studies are considered necessary.

## 7.2 Recommendations/Remedial Measures

The owner should retain a professional engineer qualified in the design and construction of dams to accomplish the following in the specified time frame.

Starting soon:

(1) Evaluate the major seepages, steepness of the downstream slope, and sinkholes on the crest of the dam and design and implement appropriate remedial measures.

(2) Design and implement procedures to rebuild or replace the middle and north spillways with sufficient capacity to prevent overtopping.

In the near future:

(1) Specify and oversee procedures for the removal of trees and brush from the embankment and downstream toe of the dam.

(2) Design and install erosion protection for the upstream slope.

In the future:

(1) Remove the 30-inch pipes and the fill upstream of the stoplog spillway.

(2) Rehabilitate or replace the low-level outlet pipe and operating mechanism.

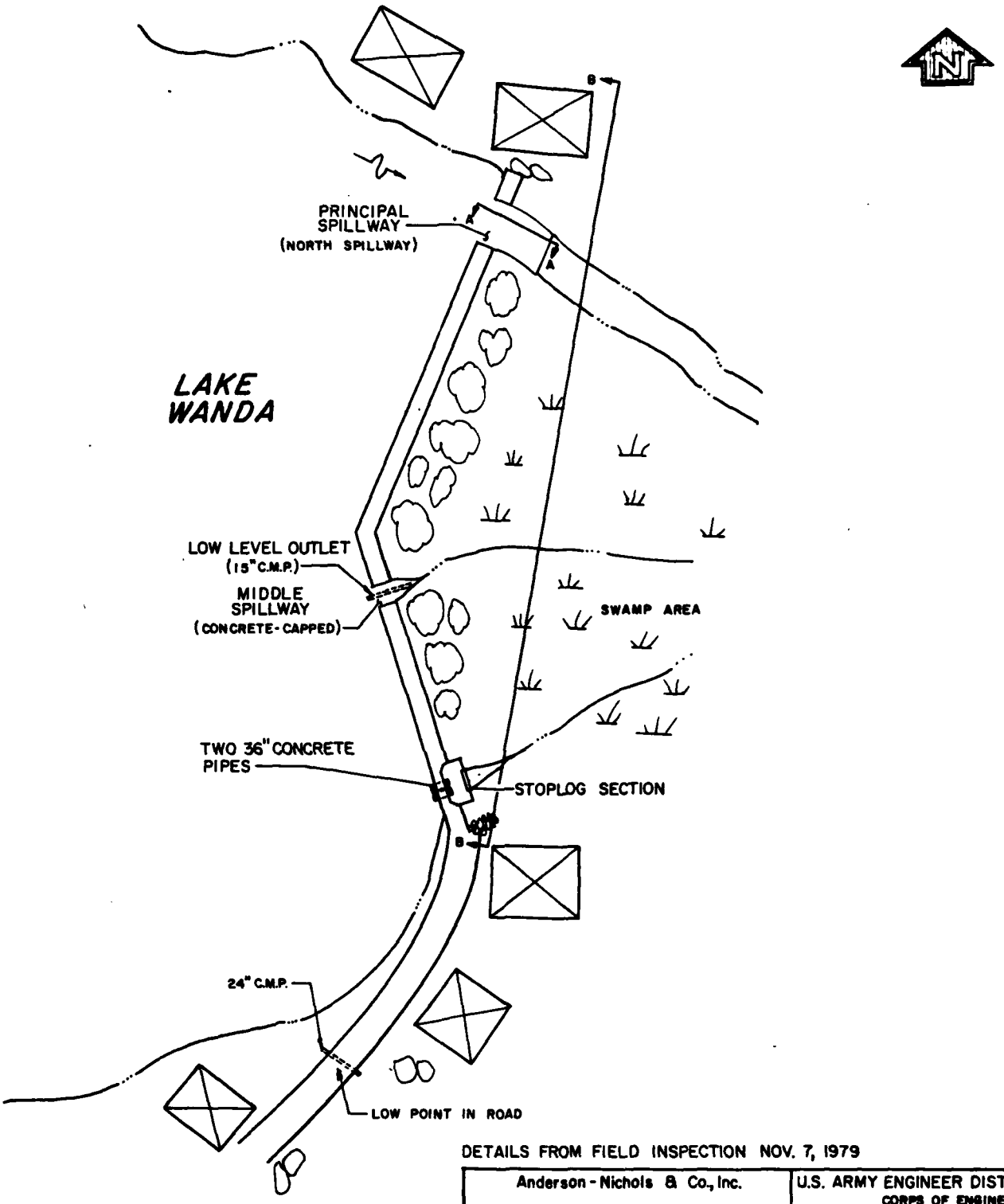
b. Operating and Maintenance Procedures.

The owner should accomplish the following in the near future:

Clear debris from the discharge channels downstream of the three spillways.

The owner should accomplish the following in the future:

Clear trees and brush from each side of the spillway discharge channels downstream of the three spillways.




DETAILS FROM FIELD INSPECTION NOV. 7, 1979

| Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE | U.S. ARMY ENGINEER DIST. PHILADELPHIA CORPS OF ENGINEERS PHILADELPHIA, PA. |
|---|---|

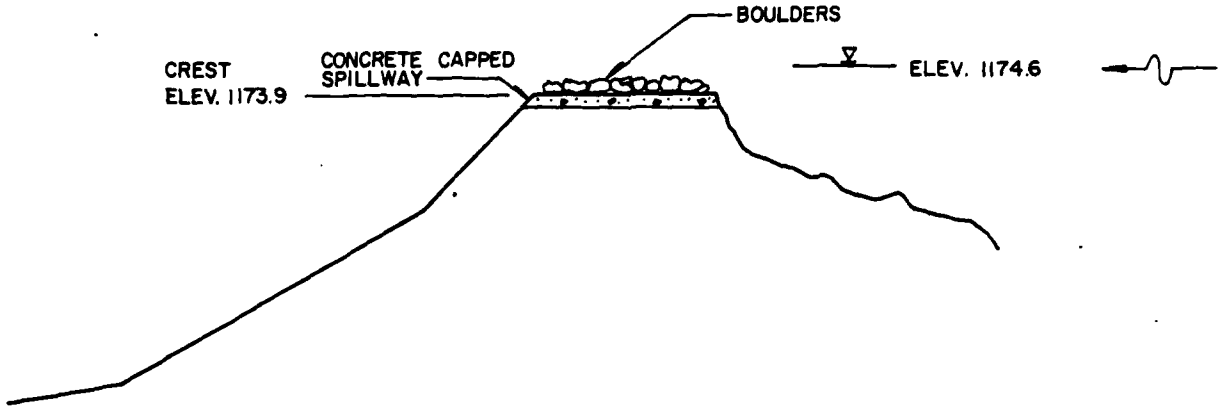
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

# LAKE WANDA DAM

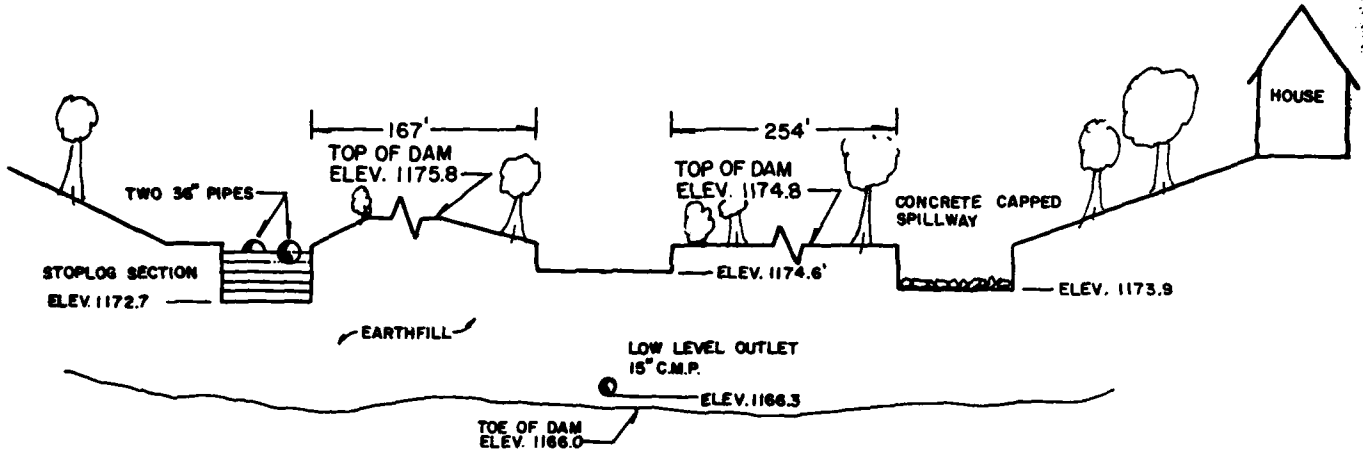
TRIB. TO WAWAYANDA CREEK NEW JERSEY

| | | | |
|---|---|---|---|
| | | | SCALE: NOT TO SCALE |
| | | | DATE: FEBRUARY 1980 |

FIGURE 1




## SECTION A-A




## ELEVATION B-B

DETAILS FROM FIELD INSPECTION NOV. 7, 1979

| | |
|---|---|
| Anderson-Nichols & Co., Inc.<br>CONCORD NEW HAMPSHIRE | U.S. ARMY ENGINEER DIST. PHILADELPHIA<br>CORPS OF ENGINEERS<br>PHILADELPHIA, PA. |

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

# LAKE WANDA DAM

TRIB. TO WAWAYANDA CREEK NEW JERSEY

| | | | |
|---|---|---|---|
| | | | SCALE: NOT TO SCALE |
| | | | DATE: FEBRUARY 1980 |

FIGURE


SCALE IN MILES

0 5 10

MAP BASED ON STATE OF NEW JERSEY OFFICIAL HIGHWAY MAP AND GUIDE.

| | |
|---|---|
| Anderson-Nichols & Co., Inc.<br>CONCORD NEW HAMPSHIRE | U.S. ARMY ENGINEER DIST. PHILADELPHIA<br>CORPS OF ENGINEERS<br>PHILADELPHIA, PA. |

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

# LAKE WANDA DAM
# LOCATION MAP

TRIBUTARY TO WAWAYANDA CREEK NEW JERSEY

| | | | |
|---|---|---|---|
| | | | SCALE: SEE BAR SCALE |
| | | | DATE: FEBRUARY 1980 |

FIGURE - 3

# Check List
# Visual Inspection
# Phase 1

Name Dam Lake Wanda Dam County Sussex State New Jersey Coordinators NJDEP

Date(s) Inspection Nov. 7, 1979 Weather cool, cloudy Temperature 40° F

Pool Elevation at Time of Inspection 1174.6' NGVD Tailwater at Time of Inspection 1166.5' NGVD

Inspection Personnel:

| | |
|---|---|
| Warren Guinan | Ronald Hirschfeld |
| Stephen Gilman | |
| Kenneth Stuart | |

Gilman/Hirschfeld Recorder

Check List
Visual Inspection
Phase 1

Name Dam Lake Wanda Dam County Sussex State New Jersey Coordinators NJDEP

Date(s) Inspection Nov. 7, 1979 Weather cool, cloudy Temperature 40° F

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Inspection Personnel:

| | |
|---|---|
| Warren Guinan | Ronald Hirschfeld |
| Stephen Gilman | |
| Kenneth Stuart | |

Gilman/Hirschfeld Recorder

EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| RAILINGS | None. | |
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | Sinkhole 6 feet from left side of middle spillway. At other junctions the embankment is not in poorer condition than the generally poor condition that it exhibits throughout its total length. | Dam is in need of major rehabilitation or reconstruction. |
| ANY NOTICEABLE SEEPAGE | Major seepages at several locations near toe of dam, up to an estimated 150-200 gpm. | Dam is in need of major rehabilitation or reconstruction. |
| STAFF GAGE AND RECORDER | None observed. | |
| DRAINS | None observed. | |

EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| RAILINGS | None. | |
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | Sinkhole 6 feet from left side of middle spillway. At other junctions the embankment is not in poorer condition than the generally poor condition that it exhibits throughout its total length. | Dam is in need of major rehabilitation or reconstruction. |
| ANY NOTICEABLE SEEPAGE | Major seepages at several locations near toe of dam, up to an estimated 150-200 gpm. | Dam is in need of major rehabilitation or reconstruction. |
| STAFF GAGE AND RECORDER | None observed. | |
| DRAINS | None observed. | |

OUTLET WORKS AND UNGATED SPILLWAY AT CENTER OF DAM

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CRACKING AND SPALLING OF CONCRETE SURFACES OF WEIRS | Concrete is badly cracked and broken. | Spillway is in need of major rehabilitation and reconstruction. |
| INTAKE STRUCTURE | Visible beneath water is a 2" rusted CMP riser. | |
| OUTLET PIPE | 15" CMP low-level outlet in downstream channel is badly rusted and deteriorated. | Check functioning of low-level outlet and rehabilitate, or if necessary, replace. |
| OUTLET CHANNEL | Bottom covered with boulders close to spillway structure before channel discharges onto flat, swampy area farther downstream. | |
| EMERGENCY GATE | Not visible. | Locate and check functioning of low-level outlet gate or valve mechanism. If possible, rehabilitate; if not, replace. |

OUTLET WORKS AND UNGATED SPILLWAY AT CENTER OF DAM

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CRACKING AND SPALLING OF CONCRETE SURFACES OF WEIRS | Concrete is badly cracked and broken. | Spillway is in need of major rehabilitation and reconstruction. |
| INTAKE STRUCTURE | Visible beneath water is a 2" rusted CMP riser. | |
| OUTLET PIPE | 15" CMP low-level outlet in downstream channel is badly rusted and deteriorated. | Check functioning of low-level outlet and rehabilitate, or if necessary, replace. |
| OUTLET CHANNEL | Bottom covered with boulders close to spillway structure before channel discharges onto flat, swampy area farther downstream. | |
| EMERGENCY GATE | Not visible. | Locate and check functioning of low-level outlet gate or valve mechanism. If possible, rehabilitate; if not, replace. |

RESERVOIR

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SLOPES | Gently sloping. Mostly occupied by cottages. No evidence of instability observed. | |
| SEDIMENTATION | No evidence of significant sedimentation observed. | |

## DOWNSTREAM CHANNEL

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONDITION (OBSTRUCTIONS, DEBRIS, ETC.) | Trees overhang all 3 channels. All are strewn with boulders and have varying amounts of debris such as barrels and timbers. | Clear debris from all 3 channels. |
| SLOPES | Flat and swampy. | |
| APPROXIMATE NO. OF HOMES AND POPULATION | None. | Low hazard. |

## INSTRUMENTATION

| VISUAL EXAMINATION | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| MONUMENTATION/SURVEYS | None observed. | |
| OBSERVATION WELLS | None observed. | |
| WEIRS | None observed. | |
| PIEZOMETERS | None observed. | |
| OTHER | None observed. | |

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

| ITEM | REMARKS |
|---|---|
| PLAN OF DAM | None revealed. |
| REGIONAL VICINITY MAP | Prepared for this report. |
| CONSTRUCTION HISTORY | None unveiled. |
| TYPICAL SECTIONS OF DAM | None. |
| HYDROLOGIC/HYDRAULIC DATA | None. |
| OUTLETS - PLAN | None. |
| - DETAILS | None found. |
| - CONSTRAINTS | None found. |
| - DISCHARGE RATINGS | None found. |
| RAINFALL/RESERVOIR RECORDS | None found. |

| ITEM | REMARKS |
|---|---|
| DESIGN REPORTS | None revealed. |
| GEOLOGY REPORTS | None revealed. |
| DESIGN COMPUTATIONS<br>HYDROLOGY & HYDRAULICS<br>DAM STABILITY<br>SEEPAGE STUDIES | None found. |
| MATERIALS INVESTIGATIONS<br>BORING RECORDS<br>LABORATORY<br>FIELD | None unveiled. |
| POST-CONSTRUCTION SURVEYS OF DAM | None revealed. |
| BORROW SOURCES | Unknown. |

| ITEM | REMARKS |
|---|---|
| MONITORING SERVICES | None. |
| MODIFICATIONS | None. |
| HIGH POOL RECORDS | None. |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS | None. |
| PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS | None. |
| MAINTENANCE OPERATION RECORDS | None. |

| ITEM | REMARKS |
|---|---|
| SPILLWAY PLAN | |
| SECTIONS | Prepared for this report from field inspection. |
| DETAILS | None. |
| OPERATING EQUIPMENT | None. |
| PLANS & DETAILS | None. |

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Mountainous, heavy forest, large lake upstream, partly suburban

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1174.6'NGVD (160 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not applicable

ELEVATION MAXIMUM DESIGN POOL: 1176.3' NGVD

ELEVATION TOP DAM: 1174.8' NGVD

NORTH SPILLWAY CREST: Free overflow concrete capped spillway

a. Elevation 1173.9' NGVD

b. Type concrete weir

c. Width 2 feet

d. Length 10 feet

e. Location Spillover north end of the dam

f. Number and Type of Gates

MIDDLE SPILLWAY CREST: Free overflow concrete capped spillway

a. Elevation 1174.6' NGVD

b. Type concrete weir

c. Width 3 feet

d. Length 16 feet

e. Location Spillover middle of the dam

f. Number and Type of Gates 15" CMP low-level outlet

STOPLOG SOUTH SPILLWAY CREST: Concrete capped with wooden stoplogs

a. Elevation 1174.7' (with stoplogs), 1172.7' (without stoplogs)

b. Type wooden stoplog weir

c. Width 3 inches

d. Length 6 feet

e. Location Spillover south end of the dam

f. Number and Type of Gates total 2 feet of stoplogs

OUTLET WORKS: One low-level outlet pipe

a. Type 15" diameter CMP pipe

b. Location below middle spillway

c. Entrance Inverts Unknown

d. Exit Inverts 1166.3' NGVD

e. Emergency Draindown Facilities (described above)

HYDROMETEORLOGICAL GAGES: None

a. Type

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 28 cfs

# APPENDIX 2

# PHOTOGRAPHS

## LAKE WANDA DAM

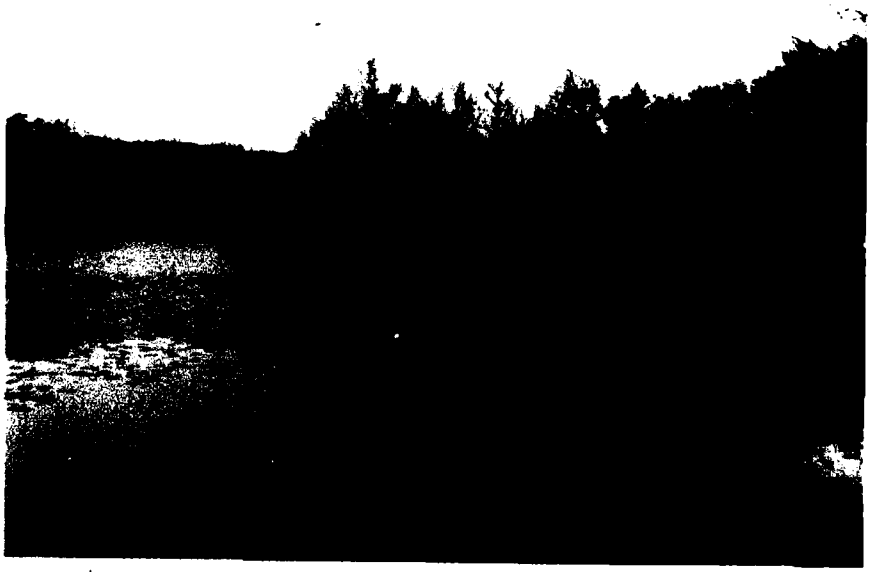
NOVEMBER 7, 1979
VIEW OF THE CREST OF THE DAM FROM RIGHT ABUTMENT LOOKING NORTH.

NOVEMBER 7, 1979
VIEW OF THE CREST OF THE DAM FROM LEFT ABUTMENT LOOKING TOWARD RIGHT ABUTMENT.

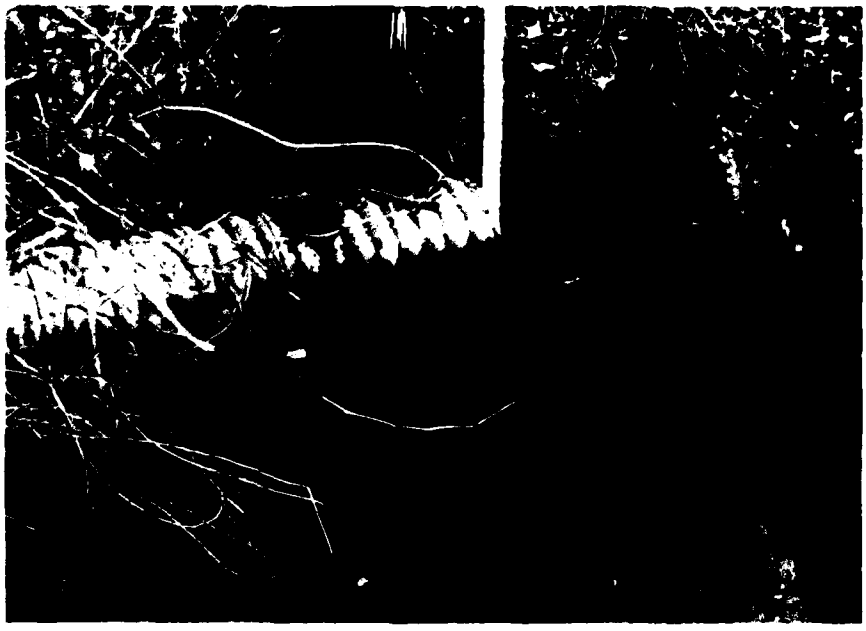
NOVEMBER 7, 1979
FREE OVERFLOW SPILLWAY LOCATED ON THE LEFT SIDE OF THE DAM (LEFT SPILLWAY).

NOVEMBER 7, 1979
MIDDLE SPILLWAY LOOKING FROM LEFT ABUTMENT.

NOVEMBER 7, 1979
VIEW OF THE STOPLOG SPILLWAY LOCATED ON THE RIGHT SIDE OF THE DAM.

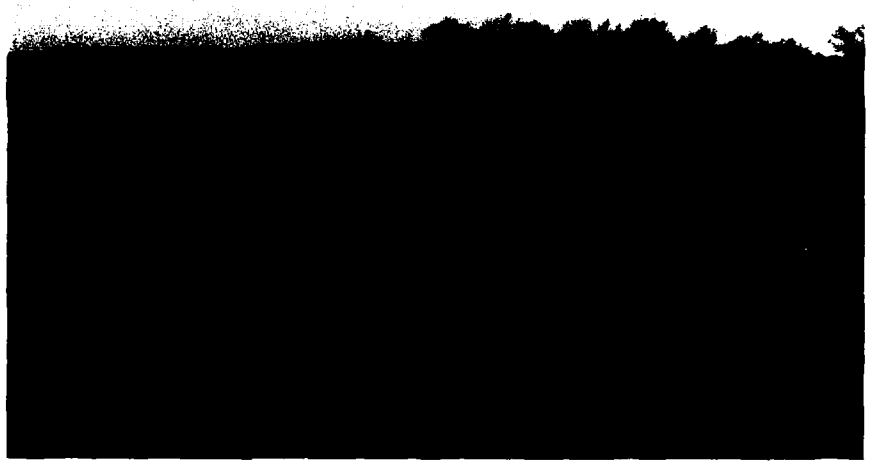


NOVEMBER 7, 1979
UPSTREAM FACE OF THE DAM FROM RIGHT EMBANKMENT.

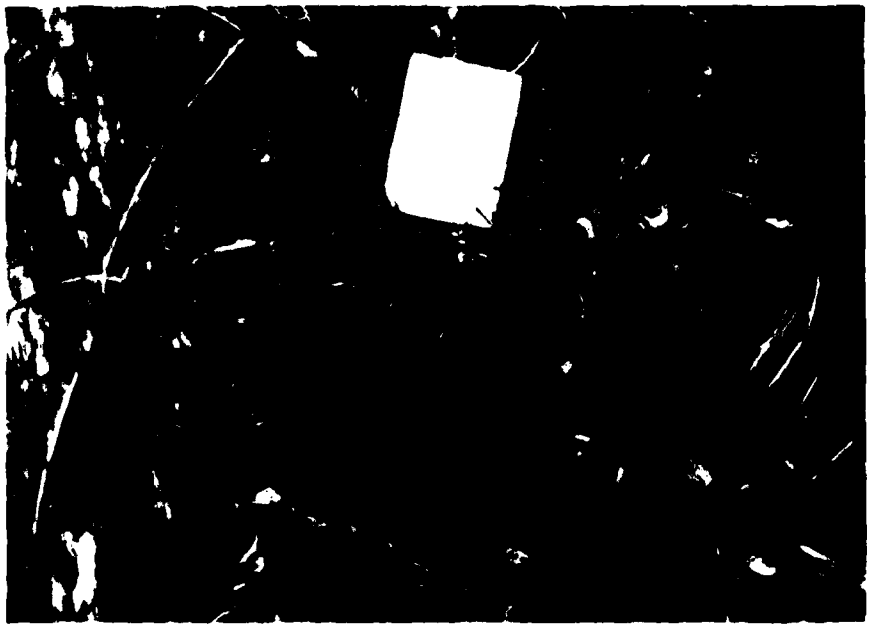


NOVEMBER 7, 1979
FIFTEEN INCH CMP LOW-LEVEL OUTLET
LOCATED BELOW MIDDLE SPILLWAY.

NOVEMBER 7, 1979
DOWNSTREAM FACE OF THE MIDDLE SPILLWAY.



NOVEMBER 7, 1979
VIEW OF THE UPSTREAM RESERVOIR FROM THE DAM CREST.



NOVEMBER 7, 1979
SEEPAGE AT THE DOWNSTREAM TOE OF THE DAM ABOUT 45 FEET TO THE RIGHT OF THE MIDDLE SPILLWAY.

LAKE WANDA DAM

NOVEMBER 7, 1979
DOWNSTREAM CHANNEL OF LEFT SPILLWAY.

NOVEMBER 7, 1979
DOWNSTREAM CHANNEL OF MIDDLE SPILLWAY.

NOVEMBER 7, 1979
DOWNSTREAM CHANNEL OF STOPLOG SPILLWAY.

# APPENDIX 3

# HYDROLOGIC COMPUTATIONS

# LAKE WANDA DAM

Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. ____ of ____

Date 1-11-80

Computed MNM

Checked ____

JOB NO. 3409-13

# HYDROLOGIC COMPUTATIONS

NAME: LAKE WANDA DAM

LOCATION: SUSSEX COUNTY, N. J.

DRAINAGE AREA: 3.48 $Mi^2$

SURFACE AREA: 31 acres

EVALUATION CRITERIA: SIZE - SMALL

HAZARD - LOW

SPILLWAY DESIGN FLOOD: BASED ON SIZE AND HAZARD CLASSIFICATION, THE SPILLWAY DESIGN FLOOD WILL BE THE 12 HOUR 100-YEAR STORM, WITH A PEAK INFLOW OF 1430 CFS.

NOTE: DRAINAGE AREA AND SURFACE AREA OF LAKE WANDA WERE PLANIMETERED OFF U.S.G.S. QUAD SHEETS.

Anderson-Nichols & Company, Inc.

Subject HIGHLAND LAKE DAM

Sheet No. 5 of

Date 1/14/80

Computed RWM

Checked TOD

JOB NO. 3409-13

SQUARES 1/4 IN. SCALE

HIGHLAND LAKE IS LOCATED WITHIN THE LAKE WANDA WATERSHED WITH A DRAINAGE AREA OF 2.28 $Mi^2$ OF THE 3.48 $Mi^2$ TOTAL DRAINAGE AREA. 100-YEAR PRECIPITATION DATA WAS USED TO DEVELOPE THE INFLOW HYDROGRAPH INTO HIGHLAND LAKE. THE INFLOW HYDROGRAPH WAS ROUTED THROUGH HIGHLAND LAKE TO DETERMINE THE OUTFLOW HYDROGRAPH. THIS OUTFLOW HYDROGRAPH WAS COMBINED WITH THE INFLOW HYDROGRAPH FROM LAKE WANDA DRAINAGE AREA. THE COMBINED HYDROGRAPH WAS THEN ROUTED TROUGH LAKE WANDA TO DETERMINE THE OUTFLOW.

SQUARES 1/4 IN. SCALE

DURING VISUAL INSPECTION, IT WAS DECIDED THAT LAKE WANDA IS A LOW-HAZARD DAM DUE TO EXISTENCE OF STORAGE AREA D/S (SWAMPS) AND BECAUSE THERE ARE NO STRUCTURES.

100-YEAR FLOOD DISCHARGE WAS CALCULATED USING STANKOWSKI'S REGRESSION EQUATION FOR NEW JERSY (100-YEAR FLOOD = 200 CFS). THE CAPACITY OF SPILLWAYS AT TOP OF DAM ELEVATION (MAXIMUM SPILLWAY CAPACITY) IS ABOUT 28 CFS.

IT WAS THEREFORE DECIDED TO USE THE 100-YEAR FLOOD AS SPILLWAY DESIGN FLOOD (SDF).

*100-YEAR PRECIPITATION DATA FOR 5, 15, 30, 60 Min, 1, 2, 3, 6, 12 ---- hrs durations WERE USED TO DEVELOPE THE PRECIPITATION HYETOGRAPH.

| 100-YEAR RAINFALL (INCHES) | DURATION |
|---|---|
| 0.755 | 5 Min |
| 1.6 | 15 " |
| 2.3 | 30 " |
| 2.9 | 60 " |
| 3.7 | 2 hrs |
| 4.2 | 3 " |
| 5.2 | 6 " |
| 6.2 | 12 " |

* 100-YEAR PRECIPITATION DATA WAS TAKEN FROM "NOAA TECHNICAL MEMORANDUM NWS HYDRO-35" AND "WEATHER BUREAU TECHNICAL PAPER NO. 40".

Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. 1 of

Date 11/6/80

Computed

Checked

JOB NO. 3409-13

SQUARES 1/4 IN. SCALE

## STANKOWSKI'S EQUATION:

$$Q_{100} = 136\ A^{0.84}\ S^{0.26}\ S_t^{-0.51}\ I^{0.14}$$

$Q_{100}$ = PEAK DISCHARGE FOR 100-YEAR INTERVAL, CFS

$A$ = DRAINAGE AREA $Mi^2$

$S$ = MAIN CHANNEL SLOPE FT/MILE

$S_t$ = SURFACE STORAGE INDEX

$I$ = INDEX OF MANMADE IMPERVIOUS COVER IN %

$$I = 0.117\ D^{0.792-0.039\log D} \qquad 1\% \leq I \leq 100\%$$

D = ~~BASIN~~ POPULATION DENSITY IN PERSON/$Mi^2$

$A = 3.48\ Mi^2$

$$S = \frac{1190-1175\ FT}{2.43\ mi} = 6.2\ FT/mi$$

$$S_t = \frac{\text{AREA OF LAKES}}{\text{TOTAL DRAINAGE AREA}}$$

AREA OF LAKES = 325 + 15 + 31 = 371 AC

$$\frac{371\ ac}{2227\ ac} = 0.17 = 17\%$$

$\boxed{S_t = 18\%}$

Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. 2 of

Date 1/10/80

Computed

Checked

JOB NO. 3409-13

SQUARES 1/4 IN. SCALE

$$D = \frac{2800 \text{ PERSONS}}{3.48 \text{ MI}^2} = 805 \frac{\text{PERSONS}}{\text{MI}^2}$$

$$I = 0.117 (805)^{0.792 - 0.039 \log 805}$$

$$I = 11\%$$

$$Q_{100} = 136 (3.48)^{0.84} (6.2)^{0.26} (18)^{-0.51} (11)^{0.14}$$

$$\boxed{Q_{100} = 200 \text{ CFS}}$$

Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. 4 of

Date 1/11/80

Computed MMM

Checked TDD

JOB NO. 3409-13

SQUARES 1/4 IN. SCALE

## 12 HOUR 100-YEAR RAINFALL DISTRIBUTION:

| NO. OF POINTS | INCHES OF RAINFALL |
|---|---|
| 36 | 0.014 |
| 18 | 0.028 |
| 6 | 0.042 |
| 6 | 0.067 |
| 3 | 0.1 |
| 1 | 0.23 |
| 1 | 0.423 |
| 1 | 0.755 |
| 1 | 0.423 |
| 1 | 0.24 |
| 1 | 0.23 |
| 3 | 0.1 |
| 6 | 0.067 |
| 6 | 0.042 |
| 18 | 0.028 |
| 36 | 0.014 |

TOTAL = 6.225 ≈ 6.2 INCHES

Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. _____ of _____

Date 1-23-80

Computed _____

Checked _____

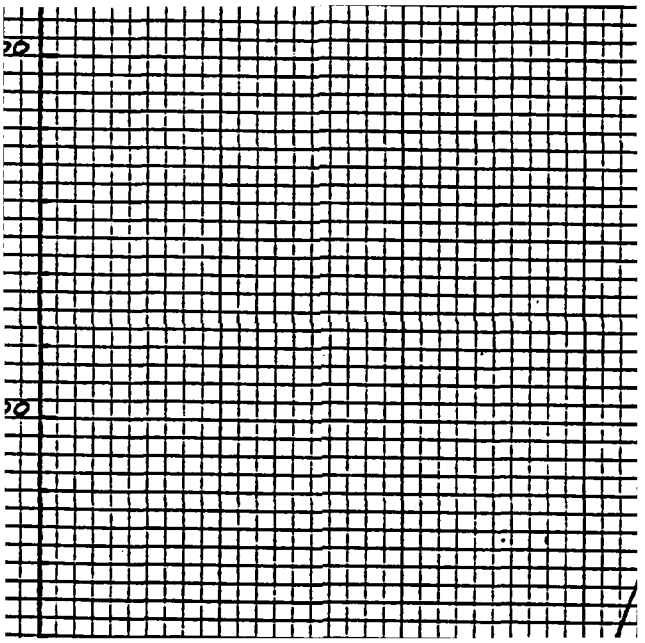
JOB NO. 3409-13

SQUARES 1/4 IN. SCALE

# HIGHLAND LAKE DAM RATING CURVE

THE RATING CURVE DATA FOR HIGHLAND LAKE DAM WAS TAKEN FROM PHASE I INSPECTION REPORT OF HIGHLAND LAKE DAM BY LOUIS BERGER & ASSOCIATES INC. DATED SEP. 25, 1979.

| ELEVATION (FT NGVD) | DISCHARGE (CFS) |
|---|---|
| 1190 | 0 |
| 1191 | 101 |
| 1192 | 425 |
| 1192.5 | 639 |
| 1193 | 917 |
| 1194 | 1404 |
| 1195 | 3113 |
| 1196 | 5832 |
| 1197 | 9239 |
| 1198 | 13193 |
| 1199 | 18574 |



Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. _____ of _____
Date 1-23-80
Computed _____
Checked _____

JOB NO. 3409-13

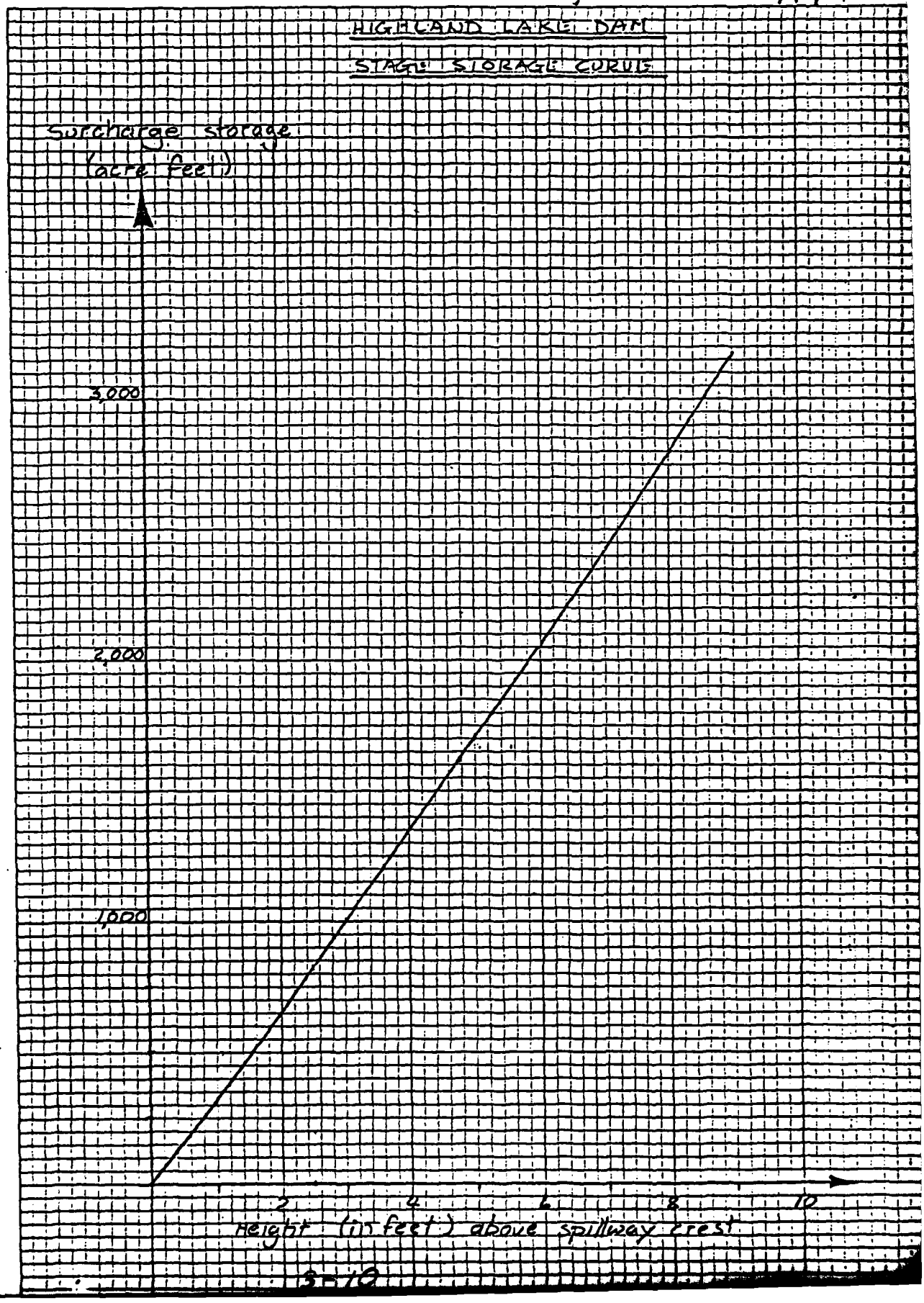
SQUARES 1/4 IN. SCALE

## STORAGE-ELEVATION DATA FOR HIGHLAND LAKE

STORAGE-ELEVATION DATA WERE TAKEN FROM PHASE I DAM INSPECTION REPORT OF SEP. 1979 FOR HIGHLAND LAKE DAM, BY LOUIS BERGER & ASSOCIATES INC.

| ELEVATION FT (NGVD) | STORAGE AC-FT |
|---|---|
| 1172 | 0 |
| 1190 | 1850 |
| 1191 | 2178 |
| 1192 | 2512 |
| 1192.5 | 2675 |
| 1193 | 2852 |
| 1194 | 3199 |
| 1195 | 3551 |
| 1196 | 3910 |
| 1197 | 4274 |
| 1198 | 4645 |
| 1199 | 5022 |

A7




46 0706

K·E 10 X 10 TO THE INCH • 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

# TIME OF CONCENTRATION DETERMINATION

## 1- SCS TR #55 METHOD

a) OVERLAND FLOW (WOODED)

LENGTH = 2700 FT

HEAD = 1440 - 1295 = 145 FT

$$SLOPE = \frac{145\ FT}{2700\ FT} = 0.054 = 5.4\%$$

FROM Fig. 3-1, PAGE 3-2

VELOCITY = 0.59 FT/sec

$$T_c = \frac{2700\ FT}{0.59\ FT/sec} = 4576\ sec = 76\ Min$$

b) CHANNEL FLOW (DEVELOPED)

LENGTH = 4550 FT

HEAD = 1295 - 1200 = 95 FT

$$SLOPE = \frac{95\ FT}{4550\ FT} = 0.021 = 2.1\%$$

HYDRAULIC RADIUS = 0.83
(ASSUME A 10'x1' RECTANGULAR CHANNEL)

USE MANNING'S EQUATION

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

WHERE $n^{*} = 0.04$

$$V = \frac{1.49}{0.04}(0.83)^{2/3}(0.021)^{1/2} = 4.8 \text{ FT/sec}$$

$$T_c = \frac{4550 \text{ FT}}{4.8 \text{ FT/sec}} = 948 \text{ sec} = 15.8 \text{ Min} \approx 16$$

TOTAL $T_c = 76 + 16 = 92$ Min

2- SOIL & WATER CONSERVATION ENGINEERING.

$$L = 0.6\, T_c$$

$$L = \frac{\ell^{0.8}(S+1)^{1.67}}{9000\, Y^{0.5}}$$

$$S = \frac{1000}{CN} - 10$$

DETERMINE THE WEIGHTED CN:

| LAND USE | PERCENT | CURVE NUMBER | PRODUCT |
|---|---|---|---|
| WOODS | 70 | 70 | 4900 |
| DEVELOPED | 30 | 90 | 2700 |
| | 100 | | 7600 |

$$\text{WEIGHTED CN} = \frac{7600}{100} = 76$$

* "n" VALUE WAS TAKEN FROM "OPEN CHANNEL HYDRAULICS" BY CHOW TABLE 5-6 PAGE 113.

$$S = \frac{1000}{76} - 10 = 3.2$$

$$l = 2700 + 4550 = 7250$$

$$Y = \frac{5.4 + 2.1}{2} = \frac{7.5}{2} = 3.75$$

$$L = \frac{(7250)^{0.8}(3.2+1)^{1.67}}{9000\,(3.75)^{0.5}} = 0.77 \text{ hrs}$$

$$T_C = \frac{0.77}{0.6} = 1.28 \text{ hrs} = 77 \text{ min}$$

## 3. TEXAS HIGHWAY VELOCITY DATA (DESIGN OF SMALL DAMS)

a) OVERLAND FLOW

SLOPE = 5.4 %

VELOCITY = 2 FT/sec

$$T_C = \frac{2700 \text{ FT}}{2 \text{ FT/sec}} = 1350 \text{ Sec} = 22.5 \text{ Min}$$

b) CHANNEL FLOW

SLOPE = 2.1 %

VELOCITY = 3 FT/sec

$$T_C = \frac{4550}{3} = 1517 \text{ Sec} = 25.3 \text{ Sec}$$

TOTAL $T_C = 22.5 + 25.3 = 47.8 \approx 48$ Min

SQUARES 1/4 IN. SCALE

## 4- KERBY METHOD

a) OVERLAND FLOW

$$T_c = 0.83\left(\frac{NL}{\sqrt{S}}\right)^{0.467}$$

$L = 2700$ FT

$N = 0.6$

$S = 0.054$

$$T_c = 0.83\left(\frac{(0.6)(2700)}{\sqrt{0.054}}\right)^{0.467} = 52 \text{ Min}$$

b) CHANNEL FLOW

$$V = \frac{1.49}{0.04}(0.83)^{2/3}(0.021)^{1/2} = 4.8 \text{ FT/sec}$$

$$T_c = \frac{4550}{4.8} = 948 \text{ Sec} = 16 \text{ Min}$$

TOTAL $T_c = 52 + 16 = 68$ Min

$$\text{AVERAGE } T_c = \frac{68 + 92 + 77 + 48}{4} = 71 \text{ Min}$$

$L$ = LAG TIME $= 0.6\,T_c = 0.6\,(71) = 42.6$ Min

**$L = 43$ Min**

Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. ____ of ____
Date 1-15-80
Computed MNM
Checked FDD

JOB NO. 3409-13

SQUARES 1/4 IN. SCALE

# TIME OF CONCENTRATION DETERMINATION

## 1- SCS TR#55 METHOD

a) OVERLAND FLOW (WOODS + SWAMPS)

LENGTH = 3800 FT

HEAD = 1460 - 1178 = 282 FT

$$SLOPE = \frac{282\ FT}{3800\ FT} = 0.074 = 7.4\%$$

FROM FIG. 3-1, PAGE 3-2

VELOCITY = 0.68 FT/sec

$$T_C = \frac{3800\ FT}{0.68\ FT/sec} = 5588\ sec = 93\ Min$$

b) CHANNEL flow

LENGTH = 3650 FT

HEAD = 1178 - 1175 = 4 FT

$$SLOPE = \frac{4}{3650} = 0.0011 = 0.11\%$$

HYDRAULIC RADIUS = 0.83

(ASSUME A 10'x1' RECTANGULAR CHANNEL)

USE MANNING'S EQUATION

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

WHERE *$n = 0.04$

$$V = \frac{1.49}{0.04} (0.83)^{2/3} (0.0011)^{1/2} = 1.1 \text{ FT/sec}$$

$$T_c = \frac{3650 \text{ FT}}{1.1 \text{ FT/sec}} = 3318 \text{ sec} = 55 \text{ Min}$$

TOTAL $T_c = 93 + 55 = 148$ Min

## 2- SOIL & WATER CONSERVATION ENGINEERING

$$L = 0.6\, T_c$$

$$L = \frac{\ell^{0.8} (S+1)^{1.67}}{9000\, y^{0.5}}$$

$$S = \frac{1000}{CN} - 10$$

$CN = 65$

* "n" VALUE WAS TAKEN FROM "OPEN CHANNEL HYDRAULIC" BY CHOW, TABLE 5-6, PAGE 113.

$$S = \frac{1000}{65} - 10 = 5.4$$

$$\ell = 3800 + 3650 = 7450 \text{ FT}$$

$$Y = \frac{7.4 + 0.11}{2} = 3.75$$

$$L = \frac{(7450)^{0.8}(5.4+1)^{1.67}}{9000\,(3.75)^{0.5}} = \frac{27800}{17428} = 1.6 \text{ hrs}$$

$$T_c = \frac{1.6}{0.6} = 2.7 \text{ hrs}$$

$T_c = 162$ Min

3_ TEXAS HIGHWAY VELOCITY DATA (DESIGN OF SMALL DAMS)

a) OVERLAND FLOW

VELOCITY = 2 FT/sec

$$T_c = \frac{3800}{2} = 1900 \text{ sec} = 32 \text{ Min}$$

b) CHANNEL FLOW

VELOCITY = 1 FT/sec

$$T_c = \frac{3650}{1} = 3650 \text{ sec} = 61 \text{ Min}$$

TOTAL $T_c$ = 93 Min

Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. ____ of ____

Date 1-16-80

Computed MNM

Checked EDD

JOB NO. 3409-13

SQUARES 1/4 IN. SCALE

## 4- KERBY METHOD

a) OVERLAND FLOW

$$T_c = 0.83 \left( \frac{NL}{\sqrt{S}} \right)^{0.467}$$

$L = 3800$ FT

$N = 0.6$

$S = 0.074$

$$T_c = 0.83 \left( \frac{(0.6)(3800)}{\sqrt{0.074}} \right)^{0.467}$$

$T_c = 56$ Min

b) CHANNEL FLOW

$$V = \frac{1.49}{0.04} (0.83)^{2/3} (0.0011)^{1/2} = 1.1 \text{ FT/sec}$$

$$T_c = \frac{3650}{1.1} = 55 \text{ Min}$$

TOTAL $T_c = 56 + 55 = 111$ min

AVERAGE $T_c = \frac{148 + 162 + 93 + 111}{4}$

AVERAGE $T_c = 128$ Min

LAG TIME $= L = (128)(0.6) = 77$ Min


VERNON
Tc REACH #1
Tc REACH #2
Barry
Lake Wanda
Upper Highland Lake
Highland Lakes
Lake
Highland
Mastodon Lake
Marshall Pond
Kampe
Cherry Ridge
Wawayanda
FLOW LINE FOR Tc

Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. ____ of ____

Date 1-23-80

Computed MNM

Checked TDD

JOB NO. 3409-13

SQUARES 1/4 IN. SCALE

## DEVELOPMENT OF RATING CURVE

1- SPILLWAY CURVE:

COMPUTE Q USING WEIR EQUATION $Q = CLH^{3/2}$ WHERE

*C = 2.7 FOR SPILLWAYS

2- TOP OF DAM CURVE:

COMPUTE Q USING $Q = CLH^{3/2}$ WHERE

*C = 2.6 FOR TOP OF DAM

* "C" VALUES WHERE TAKEN FROM BRATER & KING "HANDBOOK OF HYDRAULICS".

Anderson-Nichols & Company, Inc.

Subject LAKE WANDA DAM

Sheet No. ____ of ____

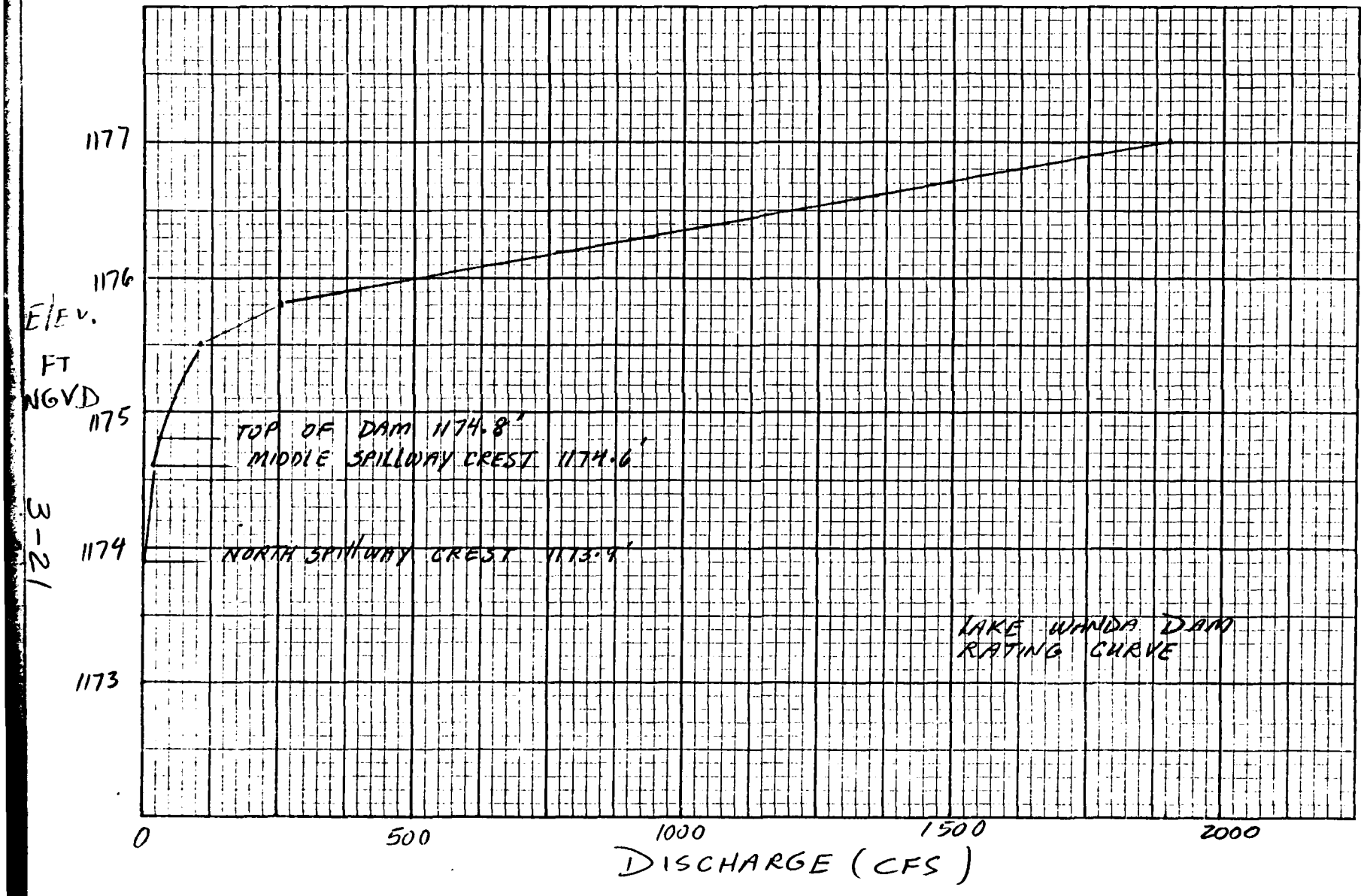
Date 1-23-80

Computed MMM

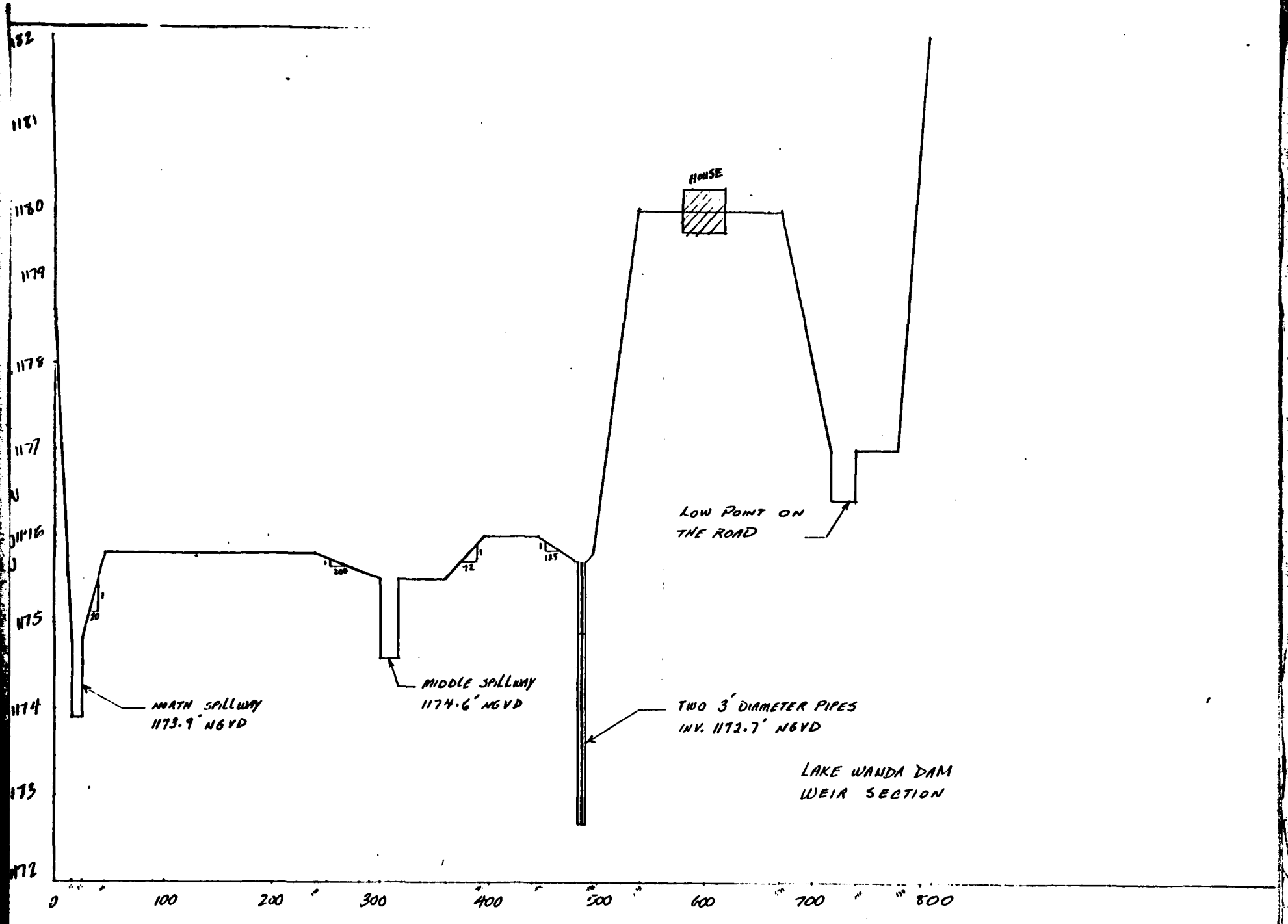
Checked FDD

JOB NO. 3409-13

| ELEVATION NGVD | SPILLWAY LEFT S.W. HEAD FT | SPILLWAY LEFT S.W. Q CFS | SPILLWAY MIDDLE S.W. HEAD FT | SPILLWAY MIDDLE S.W. Q CFS | TOTAL SPILLWAY Q CFS | TOP OF DAM HEAD FT | TOP OF DAM LENGTH FT | TOP OF DAM Q CFS | COMBINED Q CFS |
|---|---|---|---|---|---|---|---|---|---|
| 1173.9 | - | - | - | - | 0 | | | | 0 |
| 1174.6 | 0.7 | 16 | - | - | 16 | | | | 16 |
| 1174.8 | 0.9 | 23 | 0.2 | 4 | 27 | | | | 27 |
| 1175.5 | 1.6 | 55 | 0.9 | 37 | 92 | 0.7 | 14 | 11 | 103 |
| 1175.8 | 1.9 | 71 | 1.4 | 72 | 143 | 0.41 | 160 | 109 | 252 |
| 1177 | 3.1 | 147 | 2.4 | 161 | 308 | 1.47 | 407 | 1592 | 1900 |


1177
1176
1175
1174
1173
ELEV. FT NGVD
TOP OF DAM 1174.8'
MIDDLE SPILLWAY CREST 1174.6'
NORTH SPILLWAY CREST 1173.9'
LAKE WANDA DAM
RATING CURVE
0
500
1000
1500
2000
DISCHARGE (CFS)

E-21


1182
1181
1180
1179
1178
1177
1176
1175
1174
1173
1172
HOUSE
LOW POINT ON THE ROAD
NORTH SPILLWAY 1173.9' NGVD
MIDDLE SPILLWAY 1174.6' NGVD
TWO 3' DIAMETER PIPES INV. 1172.7' NGVD
LAKE WANDA DAM WEIR SECTION
0
100
200
300
400
500
600
700
800

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

# STORAGE - ELEVATION DETERMINATION

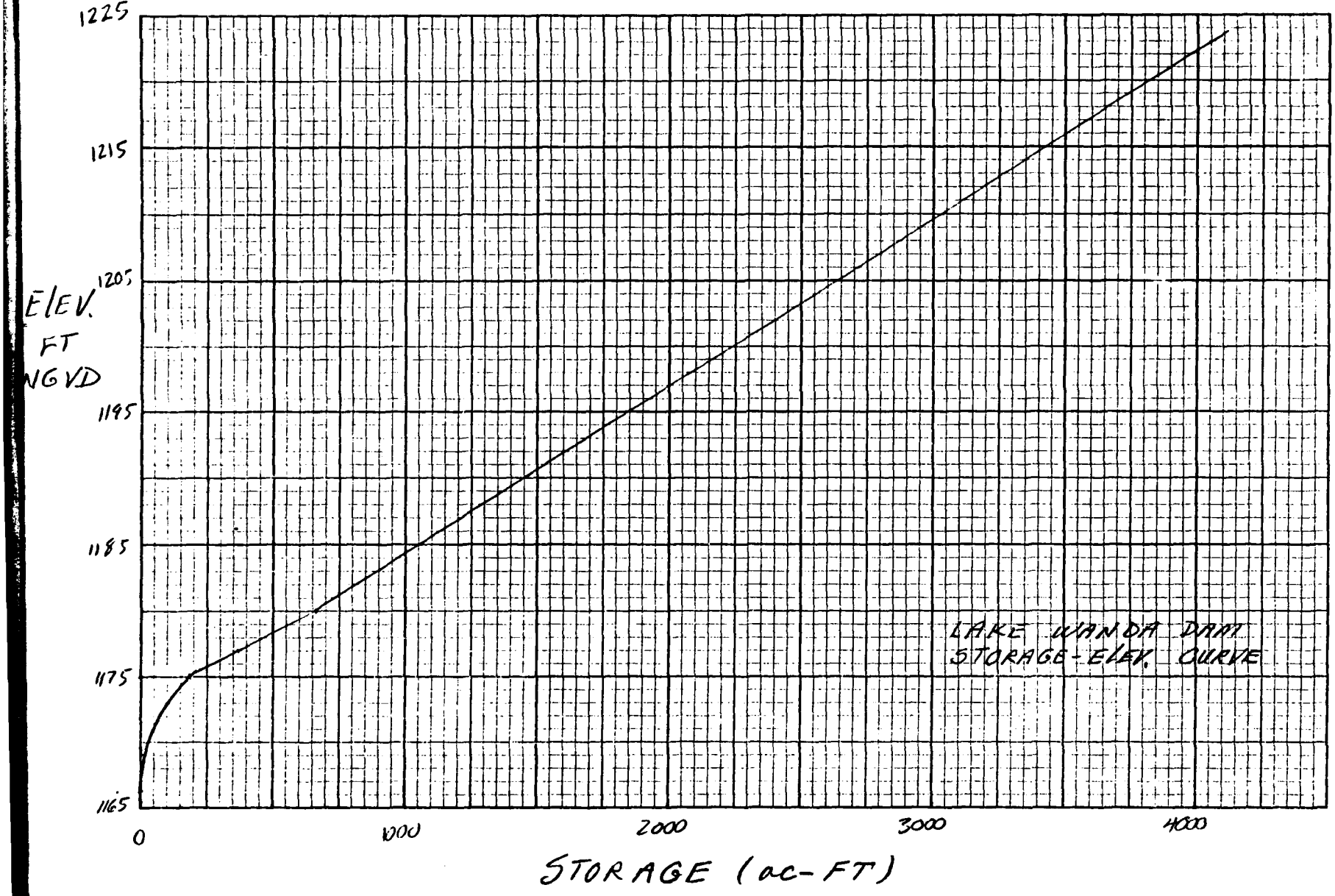
AVERAGE DEPTH OF THE LAKE = 6 FT

MAXIMUM DEPTH OF THE LAKE = 10 FT

| ELEVATION FT | SURFACE AREA AC | AVE. S. A. AC | INCREMENTAL STORAGE AC-FT | CUMULATIVE STORAGE AC-FT |
|---|---|---|---|---|
| | | 31 | 186 | 186 |
| 1175 | 31 | | | |
| | | 94.5 | 472.5 | 658.5 |
| 1180 | 158 | | | |
| | | 217 | 4340 | 4998.5 |
| 1200 | 276 | | | |

HEC-1 INPUT:

| ELEV. FT NGVD | STORAGE AC-FT |
|---|---|
| 1169 | 0 |
| 1173.9 | 150 |
| 1174.6 | 180 |
| 1174.8 | 184 |
| 1175.5 | 225 |
| 1175.8 | 250 |
| 1177 | 370 |


1225
1215
1205
1195
1185
1175
1165
ELEV. FT NGVD
0
1000
2000
3000
4000
STORAGE (ac-FT)
LAKE WANDA DAM
STORAGE-ELEV. CURVE

SQUARES 1/4 IN. SCALE

## DETERMINATION OF "C" FOR LOW LEVEL OUTLET

D = DIAMETER = 15" CMP = 1.25' CMP
N = 0.015 (SOIL & WATER CONSERVATION ENG. P. 632)
$A_P$ = AREA OF PIPE OPENNING = 1.23 $FT^2$
$L_P$ = LENGTH OF PIPE = 20'
$K_f$ = FRICTION LOSS THROUGH PIPE
$K_e$ = ENTRANCE LOSS OF PIPE = 0.8 (IBID P. 639)
$C_P$ = COEFFICIENT OF DISCHARGE (INCORPORATING $A_P$ & 2g)
C = COEFFICIENT OF DISCHARGE

$$K_f = \frac{5087\, n^2}{D^{4/3}} = \frac{(5087)(0.015)^2}{(15)^{4/3}} = 0.031$$

$$C_P = A_P \sqrt{\frac{2g}{1 + K_e + K_f L_P}} = 1.23 \sqrt{\frac{64.4}{1 + 0.8 + (0.031)(20)}} = 6.3$$

$$C = \frac{6.3/1.23}{\sqrt{64.4}} = 0.64$$

$$Q = C\sqrt{2gh}$$

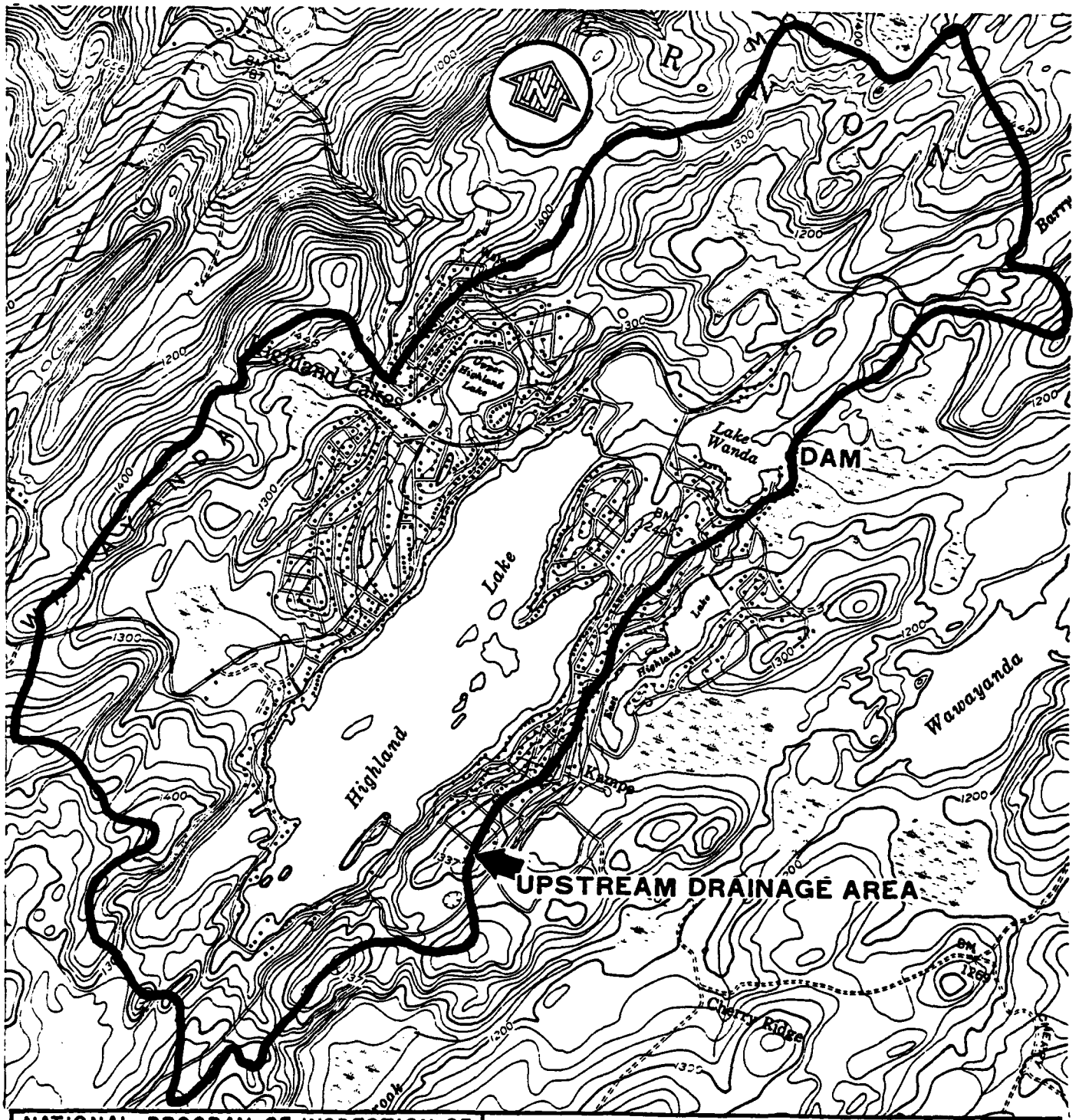
SQUARES 1/4 IN. SCALE

# DRAWDOWN CALCULATIONS

CALCULATIONS ASSUME:

1 – NO SIGNIFICANT INFLOW
2 – LOW-LEVEL OUTLET IS OPERABLE
3 – INV. U/S IS THE SAME AS INV. D/S AT GATE
4 – $Q_p = C_p H^{1/2} = 6.3 H^{1/2}$ (SEE PREVIOUS PAGE)
5 – AC-FT-DAY = 1.9835 (AVE. Q)
6 – DAYS = Δ STORAGE / AC-FT-DAY

| ELEV. FT | STORAGE AC-FT | Δ STORAGE AC-FT | H FT | Q CFS | AVE. Q CFS | AC-FT / DAY | DAYS |
|---|---|---|---|---|---|---|---|
| 1175 | 186 | | 8.7 | 18.6 | | | |
| | | 86 | | | 17.45 | 34.6 | 2.5 |
| 1173 | 100 | | 6.7 | 16.3 | | | |
| | | 50 | | | 14.95 | 29.6 | 1.7 |
| 1171 | 50 | | 4.7 | 13.6 | | | |
| | | 30 | | | 11.95 | 23.7 | 1.3 |
| 1169 | 20 | | 2.7 | 10.3 | | | |
| | | 15 | | | 7.8 | 15.6 | 0.96 |
| 1167 | 5 | | 0.7 | 5.3 | | | |
| | | 5 | | | 2.65 | 5.2 | 0.96 |
| 1166.3 | 0 | | 0 | 0 | | | |
| | | | | | | | 7.42 DAYS |




NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE WANDA DAM
VERNON TOWNSHIP, NEW JERSEY

# REGIONAL VICINITY MAP

FEBRUARY 1980

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

ANDERSON-NICHOLS & CO., INC. CONCORD, N.H.

SCALE IN MILES

0 1/2 1

MAP BASED ON U.S.G.S. 7.5 MINUTE QUADRANGLE SHEET. WAWAYANDA, N.J.-N.Y. 1954.

HEC-1 OUTPUT

OVERTOPPING ANALYSIS

LAKE WANDA DAM

```
**********
  1  A1 LAKE WANDA DAM OVERTOPPING AND BREACH ANALYSIS M-HIREMADI ANDERSON-NICHOLS
  2  A2 NEW JERSY NUMBER 22-52
  3  A3 12 HOUR 100 YEAR RAINFALL DATA WAS USED
  4  B    200       0       5       0       0       0       0       0       0       0
  5  B1     3
  6  K      0      A1                                      1
  7  K1 LAKE WANDA INFLOW HYDROGRAPH FOR HIGHLAND LAKE DRAINAGE AREA
  8  H      0       2    2.28                       0
  9  O    144
 10  O1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
 11  O1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
 12  O1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
 13  O1 0.014   0.014   0.014   0.014   0.014   0.014   0.028   0.028   0.028   0.028
 14  O1 0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028
 15  O1 0.028   0.028   0.028   0.028   0.042   0.042   0.042   0.042   0.042   0.042
 16  O1 0.067   0.067   0.067   0.067   0.067   0.067     0.1     0.1     0.1    0.23
 17  O1 0.423   0.755   0.423    0.24    0.23     0.1     0.1     0.1   0.067   0.067
 18  O1 0.067   0.067   0.067   0.067   0.042   0.042   0.042   0.042   0.042   0.042
 19  O1 0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028
 20  O1 0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.014   0.014
 21  O1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
 22  O1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
 23  O1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
 24  O1 0.014  00.014   0.014   0.014
 25  T                                               1     0.1
 26  W2          0.72
 27  X     -3
 28  K      1      A2                                      1
 29  K1 ROUTE INFLOW HYDROGRAPH THROUGH HIGHLAND LAKE RESERVOIR
 30  Y                               1       1
 31  Y1     1                                        1850      -1
 32  Y4  1190    1191    1192  1192.5    1193    1194    1195    1196    1197    1198
 33  Y4  1199
 34  Y5     0     101     425     639     917    1404    3113    5837    9239   13193
 35  Y5 18574
 36  $$     0    1850    2178    2512    2675    2852    3199    3551    3910    4274
 37  $$  4645    5022
 38  $E  1172    1190    1191    1192  1192.5    1193    1194    1195    1196    1197
 39  $E  1198    1199
 40  $$  1190
 41  $$  1199
```

```
      42  K      0      A3                                                  1
      43  K1 DEVELOP INFLOW HYDROGRAPH FOR LAKE WANDA DRAINAGE AREA
      44  M      0       2     1.2                          0
      45  D    144
      46  D1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
      47  D1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
      48  D1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
      49  D1 0.014   0.014   0.014   0.014   0.014   0.014   0.028   0.028   0.028   0.028
      50  D1 0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028
   1  51  D1 0.028   0.028   0.028   0.028   0.042   0.042   0.042   0.042   0.042   0.042
      52  D1 0.067   0.067   0.067   0.067   0.067   0.067     0.1     0.1     0.1     0.1
      53  D1 0.423   0.755   0.423    0.24    0.23     0.1     0.1     0.1   0.067   0.067
      54  D1 0.067   0.067   0.067   0.067   0.042   0.042   0.042   0.042   0.042   0.042
      55  D1 0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028
      56  D1 0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.028   0.014   0.014
      57  D1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
      58  D1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
      59  D1 0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014   0.014
      60  D1 0.014   0.014   0.014   0.014
      61  T                                                       1     0.1
      62  W2           1.3
      63  X     -3
      64  K      2      A4                                                  1
      65  K1 COMBINE HIGHLAND LAKE OUTFLOW WITH LAKE WANDA INFLOW HYDROGRAPH
      66  K      1      A5                                                  1
      67  K1 ROUTE COMBINED INFLOW HYDROGRAPH THROUGH WANDA LAKE
      68  Y                                  1       1
      69  Y1     1                                                  160      -1
      70  Y41173.9  1174.6  1174.8  1175.5  1175.8    1177
      71  Y5     0      16      28     118     276    1973
      72  $9     0     150     180     184     225     250     370
      73  $E  1169  1173.9  1174.6  1174.8  1175.5  1175.8    1177
      74  $$1173.9
      75  $D1174.8
      76  K     99
   1                  PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                            RUNOFF HYDROGRAPH AT          A1
                            ROUTE HYDROGRAPH TO           A2
                            RUNOFF HYDROGRAPH AT          A3
                            COMBINE  2 HYDROGRAPHS AT     A4
                            ROUTE HYDROGRAPH TO           A5
                            END OF NETWORK
```

**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
**********

RUN DATE= 80/01/31.
TIME= 06.02.09.

LAKE WANDA DAM OVERTOPPING AND BREACH ANALYSIS M-MIPEMADI ANDERSON-NICHOLS
NEW JERSY NUMBER 22-52
12 HOUR 100 YEAR RAINFALL DATA WAS USED

JOB SPECIFICATION

| IO | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|---|---|---|---|---|---|---|---|---|---|
| 200 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| JOPER | NWT | LROPT | TRACE |
|---|---|---|---|
| 3 | 0 | 0 | 0 |

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

LAKE WANDA INFLOW HYDROGRAPH FOR HIGHLAND LAKE DRAINAGE AREA

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 81 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | 2.28 | 0.00 | 2.28 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| IP | STORM | DAJ | DAK |
|---|---|---|---|
| 144 | 0.00 | 0.00 | 0.00 |

PRECIP PATTERN

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .03 | .03 | .03 | .03 |
| .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 |
| .03 | .03 | .03 | .03 | .04 | .04 | .04 | .04 | .04 | .04 |
| .07 | .07 | .07 | .07 | .07 | .07 | .10 | .10 | .10 | .23 |
| .42 | .76 | .42 | .24 | .23 | .10 | .10 | .10 | .07 | .07 |
| .07 | .07 | .07 | .07 | .04 | .04 | .04 | .04 | .04 | .04 |
| .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 |
| .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | | | | | | |

LOSS DATA

| LROPT | STRKR | STRTL | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSPX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 1.00 | .10 | 0.00 | 0.00 |

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .72

RECESSION DATA
STRTQ= -3.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 45 END OF PERIOD ORDINATES. TC= 0.00 HOURS. LAG= .72 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 54. | 169. | 324. | 535. | 806. | 1084. | 1250. | 1409. | 1443. | 1432. |
| 1361. | 1226. | 1055. | 928. | 750. | 614. | 512. | 427. | 363. | 305. |
| 257. | 210. | 179. | 149. | 125. | 104. | 87. | 73. | 61. | 51. |
| 43. | 36. | 30. | 25. | 21. | 18. | 15. | 13. | 11. | 9. |
| 7. | 6. | 4. | 3. | 1. | | | | | |

END-OF-PERIOD FLOW

| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | .05 | 1 | .01 | 0.00 | .01 | 7. | 1.01 | 8.25 | 101 | .03 | .02 | .01 | 648. |
| 1.01 | .10 | 2 | .01 | 0.00 | .01 | 7. | 1.01 | 8.30 | 102 | .03 | .02 | .01 | 600. |
| 1.01 | .15 | 3 | .01 | 0.00 | .01 | 7. | 1.01 | 8.35 | 103 | .03 | .02 | .01 | 560. |
| 1.01 | .20 | 4 | .01 | 0.00 | .01 | 7. | 1.01 | 8.40 | 104 | .03 | .02 | .01 | 526. |
| 1.01 | .25 | 5 | .01 | 0.00 | .01 | 7. | 1.01 | 8.45 | 105 | .03 | .02 | .01 | 497. |
| 1.01 | .30 | 6 | .01 | 0.00 | .01 | 7. | 1.01 | 8.50 | 106 | .03 | .02 | .01 | 474. |
| 1.01 | .35 | 7 | .01 | 0.00 | .01 | 7. | 1.01 | 8.55 | 107 | .03 | .02 | .01 | 455. |
| 1.01 | .40 | 8 | .01 | 0.00 | .01 | 7. | 1.01 | 9.00 | 108 | .03 | .02 | .01 | 439. |
| 1.01 | .45 | 9 | .01 | 0.00 | .01 | 7. | 1.01 | 9.05 | 109 | .01 | .01 | .01 | 424. |
| 1.01 | .50 | 10 | .01 | 0.00 | .01 | 7. | 1.01 | 9.10 | 110 | .01 | .01 | .01 | 411. |
| 1.01 | .55 | 11 | .01 | 0.00 | .01 | 7. | 1.01 | 9.15 | 111 | .01 | .01 | .01 | 396. |
| 1.01 | 1.00 | 12 | .01 | 0.00 | .01 | 7. | 1.01 | 9.20 | 112 | .01 | .01 | .01 | 380. |
| 1.01 | 1.05 | 13 | .01 | 0.00 | .01 | 7. | 1.01 | 9.25 | 113 | .01 | .01 | .01 | 361. |
| 1.01 | 1.10 | 14 | .01 | 0.00 | .01 | 7. | 1.01 | 9.30 | 114 | .01 | .01 | .01 | 339. |
| 1.01 | 1.15 | 15 | .01 | 0.00 | .01 | 7. | 1.01 | 9.35 | 115 | .01 | .01 | .01 | 315. |
| 1.01 | 1.20 | 16 | .01 | 0.00 | .01 | 7. | 1.01 | 9.40 | 116 | .01 | .01 | .01 | 288. |
| 1.01 | 1.25 | 17 | .01 | 0.00 | .01 | 7. | 1.01 | 9.45 | 117 | .01 | .01 | .01 | 266. |
| 1.01 | 1.30 | 18 | .01 | 0.00 | .01 | 7. | 1.01 | 9.50 | 118 | .01 | .01 | .01 | 243. |
| 1.01 | 1.35 | 19 | .01 | 0.00 | .01 | 7. | 1.01 | 9.55 | 119 | .01 | .01 | .01 | 222. |
| 1.01 | 1.40 | 20 | .01 | 0.00 | .01 | 7. | 1.01 | 10.00 | 120 | .01 | .01 | .01 | 204. |
| 1.01 | 1.45 | 21 | .01 | 0.00 | .01 | 7. | 1.01 | 10.05 | 121 | .01 | .01 | .01 | 187. |
| 1.01 | 1.50 | 22 | .01 | 0.00 | .01 | 7. | 1.01 | 10.10 | 122 | .01 | .01 | .01 | 173. |
| 1.01 | 1.55 | 23 | .01 | 0.00 | .01 | 7. | 1.01 | 10.15 | 123 | .01 | .01 | .01 | 162. |
| 1.01 | 2.00 | 24 | .01 | 0.00 | .01 | 7. | 1.01 | 10.20 | 124 | .01 | .01 | .01 | 153. |
| 1.01 | 2.05 | 25 | .01 | 0.00 | .01 | 7. | 1.01 | 10.25 | 125 | .01 | .01 | .01 | 145. |
| 1.01 | 2.10 | 26 | .01 | 0.00 | .01 | 7. | 1.01 | 10.30 | 126 | .01 | .01 | .01 | 139. |
| 1.01 | 2.15 | 27 | .01 | 0.00 | .01 | 7. | 1.01 | 10.35 | 127 | .01 | .01 | .01 | 134. |
| 1.01 | 2.20 | 28 | .01 | 0.00 | .01 | 7. | 1.01 | 10.40 | 128 | .01 | .01 | .01 | 129. |
| 1.01 | 2.25 | 29 | .01 | 0.00 | .01 | 7. | 1.01 | 10.45 | 129 | .01 | .01 | .01 | 125. |
| 1.01 | 2.30 | 30 | .01 | 0.00 | .01 | 7. | 1.01 | 10.50 | 130 | .01 | .01 | .01 | 122. |
| 1.01 | 2.35 | 31 | .01 | 0.00 | .01 | 7. | 1.01 | 10.55 | 131 | .01 | .01 | .01 | 120. |
| 1.01 | 2.40 | 32 | .01 | 0.00 | .01 | 7. | 1.01 | 11.00 | 132 | .01 | .01 | .01 | 117. |
| 1.01 | 2.45 | 33 | .01 | 0.00 | .01 | 7. | 1.01 | 11.05 | 133 | .01 | .01 | .01 | 116. |
| 1.01 | 2.50 | 34 | .01 | 0.00 | .01 | 7. | 1.01 | 11.10 | 134 | .01 | .01 | .01 | 114. |
| 1.01 | 2.55 | 35 | .01 | 0.00 | .01 | 7. | 1.01 | 11.15 | 135 | .01 | .01 | .01 | 113. |
| 1.01 | 3.00 | 36 | .01 | 0.00 | .01 | 7. | 1.01 | 11.20 | 136 | .01 | .01 | .01 | 112. |
| 1.01 | 3.05 | 37 | .01 | 0.00 | .01 | 7. | 1.01 | 11.25 | 137 | .01 | .01 | .01 | 111. |
| 1.01 | 3.10 | 38 | .01 | 0.00 | .01 | 7. | 1.01 | 11.30 | 138 | .01 | .01 | .01 | 110. |
| 1.01 | 3.15 | 39 | .01 | 0.00 | .01 | 7. | 1.01 | 11.35 | 139 | .01 | .01 | .01 | 110. |
| 1.01 | 3.20 | 40 | .01 | 0.00 | .01 | 7. | 1.01 | 11.40 | 140 | .01 | .01 | .01 | 109. |
| 1.01 | 3.25 | 41 | .01 | 0.00 | .01 | 7. | 1.01 | 11.45 | 141 | .01 | .01 | .01 | 109. |
| 1.01 | 3.30 | 42 | .01 | 0.00 | .01 | 7. | 1.01 | 11.50 | 142 | .01 | .01 | .01 | 108. |
| 1.01 | 3.35 | 43 | .01 | 0.00 | .01 | 7. | 1.01 | 11.55 | 143 | .01 | .01 | .01 | 108. |
| 1.01 | 3.40 | 44 | .01 | 0.00 | .01 | 7. | 1.01 | 12.00 | 144 | .01 | .01 | .01 | 108. |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 3.45 | 45 | .07 | 0.00 | .07 | 7. | 1.01 | 12.01 | 145 | 0.00 | 0.00 | 0.00 | 107. |
| 1.01 | 3.50 | 46 | .07 | 0.00 | .07 | 7. | 1.01 | 12.10 | 146 | 0.00 | 0.00 | 0.00 | 104. |
| 1.01 | 3.55 | 47 | .07 | 0.00 | .07 | 7. | 1.01 | 12.15 | 147 | 0.00 | 0.00 | 0.00 | 104. |
| 1.01 | 4.00 | 48 | .07 | 0.00 | .07 | 7. | 1.01 | 12.20 | 148 | 0.00 | 0.00 | 0.00 | 101. |
| 1.01 | 4.05 | 49 | .07 | 0.00 | .07 | 7. | 1.01 | 12.25 | 149 | 0.00 | 0.00 | 0.00 | 96. |
| 1.01 | 4.10 | 50 | .07 | 0.00 | .07 | 7. | 1.01 | 12.30 | 150 | 0.00 | 0.00 | 0.00 | 90. |
| 1.01 | 4.15 | 51 | .07 | 0.00 | .07 | 7. | 1.01 | 12.35 | 151 | 0.00 | 0.00 | 0.00 | 83. |
| 1.01 | 4.20 | 52 | .07 | 0.00 | .07 | 7. | 1.01 | 12.40 | 152 | 0.00 | 0.00 | 0.00 | 75. |
| 1.01 | 4.25 | 53 | .07 | 0.00 | .07 | 7. | 1.01 | 12.45 | 153 | 0.00 | 0.00 | 0.00 | 67. |
| 1.01 | 4.30 | 54 | .07 | .01 | .02 | 7. | 1.01 | 12.50 | 154 | 0.00 | 0.00 | 0.00 | 59. |
| 1.01 | 4.35 | 55 | .04 | .03 | .01 | 10. | 1.01 | 12.55 | 155 | 0.00 | 0.00 | 0.00 | 51. |
| 1.01 | 4.40 | 56 | .04 | .03 | .01 | 16. | 1.01 | 13.00 | 156 | 0.00 | 0.00 | 0.00 | 44. |
| 1.01 | 4.45 | 57 | .04 | .03 | .01 | 28. | 1.01 | 13.05 | 157 | 0.00 | 0.00 | 0.00 | 38. |
| 1.01 | 4.50 | 58 | .04 | .03 | .01 | 48. | 1.01 | 13.10 | 158 | 0.00 | 0.00 | 0.00 | 32. |
| 1.01 | 4.55 | 59 | .04 | .03 | .01 | 77. | 1.01 | 13.15 | 159 | 0.00 | 0.00 | 0.00 | 28. |
| 1.01 | 5.00 | 60 | .04 | .03 | .01 | 114. | 1.01 | 13.20 | 160 | 0.00 | 0.00 | 0.00 | 25. |
| 1.01 | 5.05 | 61 | .07 | .06 | .01 | 160. | 1.01 | 13.25 | 161 | 0.00 | 0.00 | 0.00 | 22. |
| 1.01 | 5.10 | 62 | .07 | .06 | .01 | 211. | 1.01 | 13.30 | 162 | 0.00 | 0.00 | 0.00 | 19. |
| 1.01 | 5.15 | 63 | .07 | .06 | .01 | 268. | 1.01 | 13.35 | 163 | 0.00 | 0.00 | 0.00 | 17. |
| 1.01 | 5.20 | 64 | .07 | .06 | .01 | 329. | 1.01 | 13.40 | 164 | 0.00 | 0.00 | 0.00 | 16. |
| 1.01 | 5.25 | 65 | .07 | .06 | .01 | 394. | 1.01 | 13.45 | 165 | 0.00 | 0.00 | 0.00 | 14. |
| 1.01 | 5.30 | 66 | .07 | .06 | .01 | 462. | 1.01 | 13.50 | 166 | 0.00 | 0.00 | 0.00 | 13. |
| 1.01 | 5.35 | 67 | .10 | .09 | .01 | 531. | 1.01 | 13.55 | 167 | 0.00 | 0.00 | 0.00 | 12. |
| 1.01 | 5.40 | 68 | .10 | .09 | .01 | 603. | 1.01 | 14.00 | 168 | 0.00 | 0.00 | 0.00 | 11. |
| 1.01 | 5.45 | 69 | .10 | .09 | .01 | 674. | 1.01 | 14.05 | 169 | 0.00 | 0.00 | 0.00 | 10. |
| 1.01 | 5.50 | 70 | .23 | .22 | .01 | 754. | 1.01 | 14.10 | 170 | 0.00 | 0.00 | 0.00 | 10. |
| 1.01 | 5.55 | 71 | .42 | .41 | .01 | 863. | 1.01 | 14.15 | 171 | 0.00 | 0.00 | 0.00 | 9. |
| 1.01 | 6.00 | 72 | .76 | .75 | .01 | 1036. | 1.01 | 14.20 | 172 | 0.00 | 0.00 | 0.00 | 9. |
| 1.01 | 6.05 | 73 | .42 | .41 | .01 | 1288. | 1.01 | 14.25 | 173 | 0.00 | 0.00 | 0.00 | 8. |
| 1.01 | 6.10 | 74 | .24 | .23 | .01 | 1618. | 1.01 | 14.30 | 174 | 0.00 | 0.00 | 0.00 | 8. |
| 1.01 | 6.15 | 75 | .23 | .22 | .01 | 2029. | 1.01 | 14.35 | 175 | 0.00 | 0.00 | 0.00 | 8. |
| 1.01 | 6.20 | 76 | .10 | .09 | .01 | 2498. | 1.01 | 14.40 | 176 | 0.00 | 0.00 | 0.00 | 8. |
| 1.01 | 6.25 | 77 | .10 | .09 | .01 | 2962. | 1.01 | 14.45 | 177 | 0.00 | 0.00 | 0.00 | 8. |
| 1.01 | 6.30 | 78 | .10 | .09 | .01 | 3350. | 1.01 | 14.50 | 178 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 6.35 | 79 | .07 | .06 | .01 | 3626. | 1.01 | 14.55 | 179 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 6.40 | 80 | .07 | .06 | .01 | 3772. | 1.01 | 15.00 | 180 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 6.45 | 81 | .07 | .06 | .01 | 3798. | 1.01 | 15.05 | 181 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 6.50 | 82 | .07 | .06 | .01 | 3711. | 1.01 | 15.10 | 182 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 6.55 | 83 | .07 | .06 | .01 | 3543. | 1.01 | 15.15 | 183 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.00 | 84 | .07 | .06 | .01 | 3312. | 1.01 | 15.20 | 184 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.05 | 85 | .04 | .03 | .01 | 3029. | 1.01 | 15.25 | 185 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.10 | 86 | .04 | .03 | .01 | 2731. | 1.01 | 15.30 | 186 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.15 | 87 | .04 | .03 | .01 | 2456. | 1.01 | 15.35 | 187 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.20 | 88 | .04 | .03 | .01 | 2212. | 1.01 | 15.40 | 188 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.25 | 89 | .04 | .03 | .01 | 1997. | 1.01 | 15.45 | 189 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.30 | 90 | .04 | .03 | .01 | 1810. | 1.01 | 15.50 | 190 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.35 | 91 | .03 | .02 | .01 | 1641. | 1.01 | 15.55 | 191 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.40 | 92 | .03 | .02 | .01 | 1488. | 1.01 | 16.00 | 192 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.45 | 93 | .03 | .02 | .01 | 1350. | 1.01 | 16.05 | 193 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.50 | 94 | .03 | .02 | .01 | 1227. | 1.01 | 16.10 | 194 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.55 | 95 | .03 | .02 | .01 | 1115. | 1.01 | 16.15 | 195 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 8.00 | 96 | .03 | .02 | .01 | 1012. | 1.01 | 16.20 | 196 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 8.05 | 97 | .03 | .02 | .01 | 920. | 1.01 | 16.25 | 197 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 8.10 | 98 | .03 | .02 | .01 | 837. | 1.01 | 16.30 | 198 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 8.15 | 99 | .03 | .02 | .01 | 765. | 1.01 | 16.35 | 199 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 8.20 | 100 | .03 | .02 | .01 | 702. | 1.01 | 16.40 | 200 | 0.00 | 0.00 | 0.00 | 7. |
| | | | | | | | | | SUM | 6.23 | 4.47 | 1.75 | 8030. |
| | | | | | | | | | | ( 158.)( 114.)( 45.)( 2274.10) | | | |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 3708. | 1067. | 401. | 401. | 88290. |
| CMS | 105. | 30. | 11. | 11. | 2274. |
| INCHES | | 4.35 | 4.55 | 4.55 | 4.55 |
| MM | | 110.60 | 115.56 | 115.56 | 115.56 |
| AC-FT | | 529. | 553. | 553. | 553. |
| THOUS CU M | | 653. | 682. | 682. | 682. |

********** ********** ********** ********** **********

## HYDROGRAPH ROUTING

ROUTE INFLOW HYDROGRAPH THROUGH HIGHLAND LAKE RESERVOIR

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| A2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | ISTR |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | 0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 1850. | -1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| STAGE | 1190.00 | 1191.00 | 1192.00 | 1192.50 | 1193.00 | 1194.00 | 1195.00 | 1196.00 | 1197.00 | 1198.00 |
| | 1199.00 | | | | | | | | | |
| FLOW | 0.00 | 101.00 | 425.00 | 639.00 | 917.00 | 1404.00 | 3113.00 | 5837.00 | 9239.00 | 13193.00 |
| | 18574.00 | | | | | | | | | |
| CAPACITY= | 0. | 1850. | 2178. | 2512. | 2675. | 2852. | 3199. | 3551. | 3910. | 4274. |
| | 4645. | 5022. | | | | | | | | |
| ELEVATION= | 1172. | 1190. | 1191. | 1192. | 1193. | 1193. | 1194. | 1195. | 1196. | 1197. |
| | 1198. | 1199. | | | | | | | | |

| CPEL | SPWID | COOW | EXPW | ELEVL | COOL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 1190.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COOD | EXPD | DAMWID |
|---|---|---|---|
| 1194.0 | 0.0 | 0.0 | 0. |

END-OF-PERIOD HYDROGRAPH ORDINATES

| MO.DA | HR.MN | PERIOD | HOURS | INFLOW | OUTFLOW | STORAGE | STAGE |
|---|---|---|---|---|---|---|---|
| 1.01 | .05 | 1 | .08 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .10 | 2 | .17 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .15 | 3 | .25 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .20 | 4 | .33 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .25 | 5 | .42 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .30 | 6 | .50 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .35 | 7 | .58 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .40 | 8 | .67 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .45 | 9 | .75 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .50 | 10 | .83 | 7. | 0. | 1850. | 1190.0 |
| 1.01 | .55 | 11 | .92 | 7. | 0. | 1851. | 1190.0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.01 | 1.00 | 12 | 1.00 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.05 | 13 | 1.08 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.10 | 14 | 1.17 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.15 | 15 | 1.25 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.20 | 16 | 1.33 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.25 | 17 | 1.42 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.30 | 18 | 1.50 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.35 | 19 | 1.58 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.40 | 20 | 1.67 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.45 | 21 | 1.75 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.50 | 22 | 1.83 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 1.55 | 23 | 1.92 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.00 | 24 | 2.00 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.05 | 25 | 2.08 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.10 | 26 | 2.17 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.15 | 27 | 2.25 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.20 | 28 | 2.33 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.25 | 29 | 2.42 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.30 | 30 | 2.50 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.35 | 31 | 2.58 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.40 | 32 | 2.67 | 7. | 0. | 1851. | 1190.0 |
| 1.01 | 2.45 | 33 | 2.75 | 7. | 0. | 1852. | 1190.0 |
| 1.01 | 2.50 | 34 | 2.83 | 7. | 0. | 1852. | 1190.0 |
| 1.01 | 2.55 | 35 | 2.92 | 7. | 0. | 1852. | 1190.0 |
| 1.01 | 3.00 | 36 | 3.00 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.05 | 37 | 3.08 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.10 | 38 | 3.17 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.15 | 39 | 3.25 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.20 | 40 | 3.33 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.25 | 41 | 3.42 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.30 | 42 | 3.50 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.35 | 43 | 3.58 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.40 | 44 | 3.67 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.45 | 45 | 3.75 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.50 | 46 | 3.83 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 3.55 | 47 | 3.92 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 4.00 | 48 | 4.00 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 4.05 | 49 | 4.08 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 4.10 | 50 | 4.17 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 4.15 | 51 | 4.25 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 4.20 | 52 | 4.33 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 4.25 | 53 | 4.42 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 4.30 | 54 | 4.50 | 7. | 1. | 1852. | 1190.0 |
| 1.01 | 4.35 | 55 | 4.58 | 10. | 1. | 1852. | 1190.0 |
| 1.01 | 4.40 | 56 | 4.67 | 16. | 1. | 1853. | 1190.0 |
| 1.01 | 4.45 | 57 | 4.75 | 28. | 1. | 1853. | 1190.0 |
| 1.01 | 4.50 | 58 | 4.83 | 48. | 1. | 1853. | 1190.0 |
| 1.01 | 4.55 | 59 | 4.92 | 77. | 1. | 1853. | 1190.0 |
| 1.01 | 5.00 | 60 | 5.00 | 114. | 1. | 1854. | 1190.0 |
| 1.01 | 5.05 | 61 | 5.08 | 160. | 2. | 1855. | 1190.0 |
| 1.01 | 5.10 | 62 | 5.17 | 211. | 2. | 1856. | 1190.0 |
| 1.01 | 5.15 | 63 | 5.25 | 268. | 2. | 1858. | 1190.0 |
| 1.01 | 5.20 | 64 | 5.33 | 329. | 3. | 1860. | 1190.0 |
| 1.01 | 5.25 | 65 | 5.42 | 394. | 4. | 1862. | 1190.0 |
| 1.01 | 5.30 | 66 | 5.50 | 462. | 5. | 1865. | 1190.0 |
| 1.01 | 5.35 | 67 | 5.58 | 531. | 6. | 1869. | 1190.1 |
| 1.01 | 5.40 | 68 | 5.67 | 603. | 7. | 1873. | 1190.1 |
| 1.01 | 5.45 | 69 | 5.75 | 674. | 8. | 1877. | 1190.1 |
| 1.01 | 5.50 | 70 | 5.83 | 754. | 10. | 1882. | 1190.1 |
| 1.01 | 5.55 | 71 | 5.92 | 863. | 11. | 1887. | 1190.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.01 | 6.00 | 72 | 6.00 | 1036. | 13. | 1894. | 1190.1 |
| 1.01 | 6.05 | 73 | 6.08 | 1288. | 16. | 1902. | 1190.2 |
| 1.01 | 6.10 | 74 | 6.17 | 1618. | 19. | 1911. | 1190.2 |
| 1.01 | 6.15 | 75 | 6.25 | 2029. | 23. | 1924. | 1190.2 |
| 1.01 | 6.20 | 76 | 6.33 | 2490. | 27. | 1939. | 1190.3 |
| 1.01 | 6.25 | 77 | 6.42 | 2962. | 33. | 1958. | 1190.3 |
| 1.01 | 6.30 | 78 | 6.50 | 3350. | 40. | 1979. | 1190.4 |
| 1.01 | 6.35 | 79 | 6.58 | 3626. | 47. | 2003. | 1190.5 |
| 1.01 | 6.40 | 80 | 6.67 | 3772. | 55. | 2028. | 1190.5 |
| 1.01 | 6.45 | 81 | 6.75 | 3798. | 63. | 2054. | 1190.6 |
| 1.01 | 6.50 | 82 | 6.83 | 3711. | 71. | 2079. | 1190.7 |
| 1.01 | 6.55 | 83 | 6.92 | 3543. | 78. | 2104. | 1190.8 |
| 1.01 | 7.00 | 84 | 7.00 | 3312. | 85. | 2127. | 1190.8 |
| 1.01 | 7.05 | 85 | 7.08 | 3029. | 92. | 2148. | 1190.9 |
| 1.01 | 7.10 | 86 | 7.17 | 2731. | 98. | 2167. | 1191.0 |
| 1.01 | 7.15 | 87 | 7.25 | 2456. | 107. | 2184. | 1191.0 |
| 1.01 | 7.20 | 88 | 7.33 | 2212. | 122. | 2200. | 1191.1 |
| 1.01 | 7.25 | 89 | 7.42 | 1997. | 135. | 2213. | 1191.1 |
| 1.01 | 7.30 | 90 | 7.50 | 1810. | 147. | 2225. | 1191.1 |
| 1.01 | 7.35 | 91 | 7.58 | 1641. | 157. | 2236. | 1191.2 |
| 1.01 | 7.40 | 92 | 7.67 | 1488. | 167. | 2246. | 1191.2 |
| 1.01 | 7.45 | 93 | 7.75 | 1350. | 175. | 2254. | 1191.2 |
| 1.01 | 7.50 | 94 | 7.83 | 1227. | 183. | 2262. | 1191.3 |
| 1.01 | 7.55 | 95 | 7.92 | 1115. | 189. | 2269. | 1191.3 |
| 1.01 | 8.00 | 96 | 8.00 | 1013. | 195. | 2275. | 1191.3 |
| 1.01 | 8.05 | 97 | 8.08 | 920. | 200. | 2280. | 1191.3 |
| 1.01 | 8.10 | 98 | 8.17 | 837. | 205. | 2285. | 1191.3 |
| 1.01 | 8.15 | 99 | 8.25 | 765. | 209. | 2289. | 1191.3 |
| 1.01 | 8.20 | 100 | 8.33 | 702. | 212. | 2293. | 1191.3 |
| 1.01 | 8.25 | 101 | 8.42 | 648. | 215. | 2296. | 1191.4 |
| 1.01 | 8.30 | 102 | 8.50 | 600. | 218. | 2298. | 1191.4 |
| 1.01 | 8.35 | 103 | 8.58 | 560. | 220. | 2301. | 1191.4 |
| 1.01 | 8.40 | 104 | 8.67 | 526. | 222. | 2303. | 1191.4 |
| 1.01 | 8.45 | 105 | 8.75 | 497. | 224. | 2305. | 1191.4 |
| 1.01 | 8.50 | 106 | 8.83 | 474. | 226. | 2307. | 1191.4 |
| 1.01 | 8.55 | 107 | 8.92 | 455. | 228. | 2309. | 1191.4 |
| 1.01 | 9.00 | 108 | 9.00 | 439. | 229. | 2310. | 1191.4 |
| 1.01 | 9.05 | 109 | 9.08 | 424. | 230. | 2311. | 1191.4 |
| 1.01 | 9.10 | 110 | 9.17 | 411. | 232. | 2313. | 1191.4 |
| 1.01 | 9.15 | 111 | 9.25 | 396. | 233. | 2314. | 1191.4 |
| 1.01 | 9.20 | 112 | 9.33 | 380. | 234. | 2315. | 1191.4 |
| 1.01 | 9.25 | 113 | 9.42 | 361. | 235. | 2316. | 1191.4 |
| 1.01 | 9.30 | 114 | 9.50 | 339. | 236. | 2317. | 1191.4 |
| 1.01 | 9.35 | 115 | 9.58 | 315. | 236. | 2317. | 1191.4 |
| 1.01 | 9.40 | 116 | 9.67 | 290. | 237. | 2318. | 1191.4 |
| 1.01 | 9.45 | 117 | 9.75 | 266. | 237. | 2318. | 1191.4 |
| 1.01 | 9.50 | 118 | 9.83 | 243. | 237. | 2318. | 1191.4 |
| 1.01 | 9.55 | 119 | 9.92 | 222. | 237. | 2318. | 1191.4 |
| 1.01 | 10.00 | 120 | 10.00 | 204. | 237. | 2318. | 1191.4 |
| 1.01 | 10.05 | 121 | 10.08 | 187. | 237. | 2318. | 1191.4 |
| 1.01 | 10.10 | 122 | 10.17 | 173. | 236. | 2317. | 1191.4 |
| 1.01 | 10.15 | 123 | 10.25 | 162. | 236. | 2317. | 1191.4 |
| 1.01 | 10.20 | 124 | 10.33 | 153. | 235. | 2316. | 1191.4 |
| 1.01 | 10.25 | 125 | 10.42 | 145. | 235. | 2316. | 1191.4 |
| 1.01 | 10.30 | 126 | 10.50 | 139. | 234. | 2315. | 1191.4 |
| 1.01 | 10.35 | 127 | 10.58 | 134. | 233. | 2314. | 1191.4 |
| 1.01 | 10.40 | 128 | 10.67 | 129. | 233. | 2314. | 1191.4 |
| 1.01 | 10.45 | 129 | 10.75 | 125. | 232. | 2313. | 1191.4 |
| 1.01 | 10.50 | 130 | 10.83 | 122. | 231. | 2312. | 1191.4 |
| 1.01 | 10.55 | 131 | 10.92 | 120. | 231. | 2312. | 1191.4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.01 | 11.00 | 132 | 11.00 | 117. | 230. | 2311. | 1191.4 |
| 1.01 | 11.05 | 133 | 11.08 | 116. | 229. | 2310. | 1191.4 |
| 1.01 | 11.10 | 134 | 11.17 | 114. | 228. | 2309. | 1191.4 |
| 1.01 | 11.15 | 135 | 11.25 | 113. | 228. | 2308. | 1191.4 |
| 1.01 | 11.20 | 136 | 11.33 | 112. | 227. | 2308. | 1191.4 |
| 1.01 | 11.25 | 137 | 11.42 | 111. | 226. | 2307. | 1191.4 |
| 1.01 | 11.30 | 138 | 11.50 | 110. | 225. | 2306. | 1191.4 |
| 1.01 | 11.35 | 139 | 11.58 | 110. | 224. | 2305. | 1191.4 |
| 1.01 | 11.40 | 140 | 11.67 | 109. | 224. | 2304. | 1191.4 |
| 1.01 | 11.45 | 141 | 11.75 | 109. | 223. | 2304. | 1191.4 |
| 1.01 | 11.50 | 142 | 11.83 | 108. | 222. | 2303. | 1191.4 |
| 1.01 | 11.55 | 143 | 11.92 | 108. | 221. | 2302. | 1191.4 |
| 1.01 | 12.00 | 144 | 12.00 | 108. | 221. | 2301. | 1191.4 |
| 1.01 | 12.05 | 145 | 12.08 | 107. | 220. | 2301. | 1191.4 |
| 1.01 | 12.10 | 146 | 12.17 | 106. | 219. | 2300. | 1191.4 |
| 1.01 | 12.15 | 147 | 12.25 | 104. | 218. | 2299. | 1191.4 |
| 1.01 | 12.20 | 148 | 12.33 | 101. | 218. | 2298. | 1191.4 |
| 1.01 | 12.25 | 149 | 12.42 | 96. | 217. | 2297. | 1191.4 |
| 1.01 | 12.30 | 150 | 12.50 | 90. | 216. | 2297. | 1191.4 |
| 1.01 | 12.35 | 151 | 12.58 | 83. | 215. | 2296. | 1191.4 |
| 1.01 | 12.40 | 152 | 12.67 | 75. | 214. | 2295. | 1191.3 |
| 1.01 | 12.45 | 153 | 12.75 | 67. | 213. | 2294. | 1191.3 |
| 1.01 | 12.50 | 154 | 12.83 | 58. | 212. | 2293. | 1191.3 |
| 1.01 | 12.55 | 155 | 12.92 | 51. | 211. | 2292. | 1191.3 |
| 1.01 | 13.00 | 156 | 13.00 | 44. | 210. | 2290. | 1191.3 |
| 1.01 | 13.05 | 157 | 13.08 | 38. | 209. | 2289. | 1191.3 |
| 1.01 | 13.10 | 158 | 13.17 | 32. | 208. | 2288. | 1191.3 |
| 1.01 | 13.15 | 159 | 13.25 | 28. | 207. | 2287. | 1191.3 |
| 1.01 | 13.20 | 160 | 13.33 | 25. | 205. | 2286. | 1191.3 |
| 1.01 | 13.25 | 161 | 13.42 | 22. | 204. | 2284. | 1191.3 |
| 1.01 | 13.30 | 162 | 13.50 | 19. | 203. | 2283. | 1191.3 |
| 1.01 | 13.35 | 163 | 13.58 | 17. | 202. | 2282. | 1191.3 |
| 1.01 | 13.40 | 164 | 13.67 | 16. | 201. | 2281. | 1191.3 |
| 1.01 | 13.45 | 165 | 13.75 | 14. | 199. | 2279. | 1191.3 |
| 1.01 | 13.50 | 166 | 13.83 | 13. | 198. | 2278. | 1191.3 |
| 1.01 | 13.55 | 167 | 13.92 | 12. | 197. | 2277. | 1191.3 |
| 1.01 | 14.00 | 168 | 14.00 | 11. | 196. | 2276. | 1191.3 |
| 1.01 | 14.05 | 169 | 14.08 | 10. | 194. | 2274. | 1191.3 |
| 1.01 | 14.10 | 170 | 14.17 | 10. | 193. | 2273. | 1191.3 |
| 1.01 | 14.15 | 171 | 14.25 | 9. | 192. | 2272. | 1191.3 |
| 1.01 | 14.20 | 172 | 14.33 | 9. | 191. | 2270. | 1191.3 |
| 1.01 | 14.25 | 173 | 14.42 | 9. | 189. | 2269. | 1191.3 |
| 1.01 | 14.30 | 174 | 14.50 | 8. | 188. | 2268. | 1191.3 |
| 1.01 | 14.35 | 175 | 14.58 | 8. | 187. | 2267. | 1191.3 |
| 1.01 | 14.40 | 176 | 14.67 | 8. | 186. | 2266. | 1191.3 |
| 1.01 | 14.45 | 177 | 14.75 | 8. | 185. | 2264. | 1191.3 |
| 1.01 | 14.50 | 178 | 14.83 | 7. | 184. | 2263. | 1191.3 |
| 1.01 | 14.55 | 179 | 14.92 | 7. | 182. | 2262. | 1191.3 |
| 1.01 | 15.00 | 180 | 15.00 | 7. | 181. | 2261. | 1191.2 |
| 1.01 | 15.05 | 181 | 15.08 | 7. | 180. | 2259. | 1191.2 |
| 1.01 | 15.10 | 182 | 15.17 | 7. | 179. | 2258. | 1191.2 |
| 1.01 | 15.15 | 183 | 15.25 | 7. | 178. | 2257. | 1191.2 |
| 1.01 | 15.20 | 184 | 15.33 | 7. | 177. | 2256. | 1191.2 |
| 1.01 | 15.25 | 185 | 15.42 | 7. | 175. | 2255. | 1191.2 |
| 1.01 | 15.30 | 186 | 15.50 | 7. | 174. | 2254. | 1191.2 |
| 1.01 | 15.35 | 187 | 15.58 | 7. | 173. | 2252. | 1191.2 |
| 1.01 | 15.40 | 188 | 15.67 | 7. | 172. | 2251. | 1191.2 |
| 1.01 | 15.45 | 189 | 15.75 | 7. | 171. | 2250. | 1191.2 |
| 1.01 | 15.50 | 190 | 15.83 | 7. | 170. | 2249. | 1191.2 |
| 1.01 | 15.55 | 191 | 15.92 | 7. | 169. | 2248. | 1191.2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.01 | 16.00 | 192 | 16.00 | 7. | 168. | 2247. | 1191.2 |
| 1.01 | 16.05 | 193 | 16.08 | 7. | 167. | 2246. | 1191.2 |
| 1.01 | 16.10 | 194 | 16.17 | 7. | 166. | 2245. | 1191.2 |
| 1.01 | 16.15 | 195 | 16.25 | 7. | 165. | 2244. | 1191.2 |
| 1.01 | 16.20 | 196 | 16.33 | 7. | 164. | 2242. | 1191.2 |
| 1.01 | 16.25 | 197 | 16.42 | 7. | 162. | 2241. | 1191.2 |
| 1.01 | 16.30 | 198 | 16.50 | 7. | 161. | 2240. | 1191.2 |
| 1.01 | 16.35 | 199 | 16.58 | 7. | 160. | 2239. | 1191.2 |
| 1.01 | 16.40 | 200 | 16.67 | 7. | 159. | 2238. | 1191.2 |

PEAK OUTFLOW IS 237. AT TIME 9.83 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 237. | 221. | 120. | 120. | 23926. |
| CMS | 7. | 6. | 3. | 3. | 678. |
| INCHES | | .90 | 1.36 | 1.36 | 1.36 |
| MM | | 22.94 | 34.44 | 34.44 | 34.44 |
| AC-FT | | 110. | 165. | 165. | 165. |
| THOUS CU M | | 135. | 203. | 203. | 203. |

**********

SUB-AREA RUNOFF COMPUTATION

DEVELOP INFLOW HYDROGRAPH FOR LAKE WANDA DRAINAGE AREA

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 43 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 2 | 1.20 | 0.00 | 1.20 | 0.00 | 0.000 | 0 | 0 | 0 |

PRECIP DATA

| IP | STORM | DAJ | DAK |
|---|---|---|---|
| 144 | 0.00 | 0.00 | 0.00 |

PRECIP PATTERN

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 |
| .03 | .03 | .03 | .03 | .04 | .04 | .04 | .04 | .04 | .04 |
| .07 | .07 | .07 | .07 | .07 | .07 | .10 | .10 | .10 | .10 |
| .42 | .76 | .42 | .24 | .23 | .10 | .10 | .10 | .07 | .07 |
| .07 | .07 | .07 | .07 | .04 | .04 | .04 | .04 | .04 | .04 |
| .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 |
| .03 | .03 | .03 | .03 | .03 | .03 | .03 | .03 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 | .01 |
| .01 | .01 | .01 | .01 | | | | | | |

LOSS DATA

| LOPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CRSTL | ALSPX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | 1.00 | .10 | 0.00 | 0.00 |

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 1.30

RECESSION DATA
STRTQ= -3.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 80 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.30 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5. | 20. | 39. | 62. | 88. | 120. | 158. | 201. | 251. | 300. |
| 343. | 376. | 404. | 420. | 429. | 432. | 429. | 423. | 407. | 389. |
| 370. | 348. | 325. | 299. | 280. | 255. | 209. | 187. | 168. | 152. |
| 137. | 124. | 113. | 103. | 94. | 85. | 77. | 69. | 62. | 56. |
| 51. | 46. | 42. | 38. | 34. | 31. | 28. | 25. | 22. | 20. |
| 18. | 17. | 15. | 14. | 12. | 11. | 10. | 9. | 8. | 7. |
| 7. | 6. | 6. | 5. | 5. | 4. | 4. | 4. | 3. | 3. |
| 3. | 2. | 2. | 2. | 1. | 1. | 1. | 1. | 0. | 0. |

END-OF-PERIOD FLOW

| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | .05 | 1 | .01 | 0.00 | .01 | 4. | 1.01 | 8.25 | 101 | .03 | .02 | .01 | 725. |
| 1.01 | .10 | 2 | .01 | 0.00 | .01 | 4. | 1.01 | 8.30 | 102 | .03 | .02 | .01 | 679. |
| 1.01 | .15 | 3 | .01 | 0.00 | .01 | 4. | 1.01 | 8.35 | 103 | .03 | .02 | .01 | 637. |
| 1.01 | .20 | 4 | .01 | 0.00 | .01 | 4. | 1.01 | 8.40 | 104 | .03 | .02 | .01 | 599. |
| 1.01 | .25 | 5 | .01 | 0.00 | .01 | 4. | 1.01 | 8.45 | 105 | .03 | .02 | .01 | 563. |
| 1.01 | .30 | 6 | .01 | 0.00 | .01 | 4. | 1.01 | 8.50 | 106 | .03 | .02 | .01 | 530. |
| 1.01 | .35 | 7 | .01 | 0.00 | .01 | 4. | 1.01 | 8.55 | 107 | .03 | .02 | .01 | 499. |
| 1.01 | .40 | 8 | .01 | 0.00 | .01 | 4. | 1.01 | 9.00 | 108 | .03 | .02 | .01 | 470. |
| 1.01 | .45 | 9 | .01 | 0.00 | .01 | 4. | 1.01 | 9.05 | 109 | .01 | .01 | .01 | 443. |
| 1.01 | .50 | 10 | .01 | 0.00 | .01 | 4. | 1.01 | 9.10 | 110 | .01 | .01 | .01 | 418. |
| 1.01 | .55 | 11 | .01 | 0.00 | .01 | 4. | 1.01 | 9.15 | 111 | .01 | .01 | .01 | 395. |
| 1.01 | 1.00 | 12 | .01 | 0.00 | .01 | 4. | 1.01 | 9.20 | 112 | .01 | .01 | .01 | 374. |
| 1.01 | 1.05 | 13 | .01 | 0.00 | .01 | 4. | 1.01 | 9.25 | 113 | .01 | .01 | .01 | 355. |
| 1.01 | 1.10 | 14 | .01 | 0.00 | .01 | 4. | 1.01 | 9.30 | 114 | .01 | .01 | .01 | 337. |
| 1.01 | 1.15 | 15 | .01 | 0.00 | .01 | 4. | 1.01 | 9.35 | 115 | .01 | .01 | .01 | 319. |
| 1.01 | 1.20 | 16 | .01 | 0.00 | .01 | 4. | 1.01 | 9.40 | 116 | .01 | .01 | .01 | 303. |
| 1.01 | 1.25 | 17 | .01 | 0.00 | .01 | 4. | 1.01 | 9.45 | 117 | .01 | .01 | .01 | 287. |
| 1.01 | 1.30 | 18 | .01 | 0.00 | .01 | 4. | 1.01 | 9.50 | 118 | .01 | .01 | .01 | 272. |
| 1.01 | 1.35 | 19 | .01 | 0.00 | .01 | 4. | 1.01 | 9.55 | 119 | .01 | .01 | .01 | 257. |
| 1.01 | 1.40 | 20 | .01 | 0.00 | .01 | 4. | 1.01 | 10.00 | 120 | .01 | .01 | .01 | 243. |
| 1.01 | 1.45 | 21 | .01 | 0.00 | .01 | 4. | 1.01 | 10.05 | 121 | .01 | .01 | .01 | 229. |
| 1.01 | 1.50 | 22 | .01 | 0.00 | .01 | 4. | 1.01 | 10.10 | 122 | .01 | .01 | .01 | 216. |
| 1.01 | 1.55 | 23 | .01 | 0.00 | .01 | 4. | 1.01 | 10.15 | 123 | .01 | .01 | .01 | 204. |
| 1.01 | 2.00 | 24 | .01 | 0.00 | .01 | 4. | 1.01 | 10.20 | 124 | .01 | .01 | .01 | 192. |
| 1.01 | 2.05 | 25 | .01 | 0.00 | .01 | 4. | 1.01 | 10.25 | 125 | .01 | .01 | .01 | 180. |
| 1.01 | 2.10 | 26 | .01 | 0.00 | .01 | 4. | 1.01 | 10.30 | 126 | .01 | .01 | .01 | 169. |
| 1.01 | 2.15 | 27 | .01 | 0.00 | .01 | 4. | 1.01 | 10.35 | 127 | .01 | .01 | .01 | 159. |
| 1.01 | 2.20 | 28 | .01 | 0.00 | .01 | 4. | 1.01 | 10.40 | 128 | .01 | .01 | .01 | 150. |
| 1.01 | 2.25 | 29 | .01 | 0.00 | .01 | 4. | 1.01 | 10.45 | 129 | .01 | .01 | .01 | 141. |
| 1.01 | 2.30 | 30 | .01 | 0.00 | .01 | 4. | 1.01 | 10.50 | 130 | .01 | .01 | .01 | 133. |
| 1.01 | 2.35 | 31 | .01 | 0.00 | .01 | 4. | 1.01 | 10.55 | 131 | .01 | .01 | .01 | 125. |
| 1.01 | 2.40 | 32 | .01 | 0.00 | .01 | 4. | 1.01 | 11.00 | 132 | .01 | .01 | .01 | 119. |
| 1.01 | 2.45 | 33 | .01 | 0.00 | .01 | 4. | 1.01 | 11.05 | 133 | .01 | .01 | .01 | 112. |
| 1.01 | 2.50 | 34 | .01 | 0.00 | .01 | 4. | 1.01 | 11.10 | 134 | .01 | .01 | .01 | 107. |
| 1.01 | 2.55 | 35 | .01 | 0.00 | .01 | 4. | 1.01 | 11.15 | 135 | .01 | .01 | .01 | 102. |
| 1.01 | 3.00 | 36 | .01 | 0.00 | .01 | 4. | 1.01 | 11.20 | 136 | .01 | .01 | .01 | 98. |
| 1.01 | 3.05 | 37 | .03 | 0.00 | .03 | 4. | 1.01 | 11.25 | 137 | .01 | .01 | .01 | 94. |
| 1.01 | 3.10 | 38 | .03 | 0.00 | .03 | 4. | 1.01 | 11.30 | 138 | .01 | .01 | .01 | 90. |
| 1.01 | 3.15 | 39 | .03 | 0.00 | .03 | 4. | 1.01 | 11.35 | 139 | .01 | .01 | .01 | 87. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 3.20 | 40 | .03 | 0.00 | .03 | 4. | 1.01 | 11.40 | 140 | .01 | .01 | .01 | 84. |
| 1.01 | 3.25 | 41 | .03 | 0.00 | .03 | 4. | 1.01 | 11.45 | 141 | .01 | .01 | .01 | 82. |
| 1.01 | 3.30 | 42 | .03 | 0.00 | .03 | 4. | 1.01 | 11.50 | 142 | .01 | .01 | .01 | 79. |
| 1.01 | 3.35 | 43 | .03 | 0.00 | .03 | 4. | 1.01 | 11.55 | 143 | .01 | .01 | .01 | 77. |
| 1.01 | 3.40 | 44 | .03 | 0.00 | .03 | 4. | 1.01 | 12.00 | 144 | .01 | .01 | .01 | 75. |
| 1.01 | 3.45 | 45 | .03 | 0.00 | .03 | 4. | 1.01 | 12.05 | 145 | 0.00 | 0.00 | 0.00 | 72. |
| 1.01 | 3.50 | 46 | .03 | 0.00 | .03 | 4. | 1.01 | 12.10 | 146 | 0.00 | 0.00 | 0.00 | 71. |
| 1.01 | 3.55 | 47 | .03 | 0.00 | .03 | 4. | 1.01 | 12.15 | 147 | 0.00 | 0.00 | 0.00 | 69. |
| 1.01 | 4.00 | 48 | .03 | 0.00 | .03 | 4. | 1.01 | 12.20 | 148 | 0.00 | 0.00 | 0.00 | 67. |
| 1.01 | 4.05 | 49 | .03 | 0.00 | .03 | 4. | 1.01 | 12.25 | 149 | 0.00 | 0.00 | 0.00 | 65. |
| 1.01 | 4.10 | 50 | .03 | 0.00 | .03 | 4. | 1.01 | 12.30 | 150 | 0.00 | 0.00 | 0.00 | 63. |
| 1.01 | 4.15 | 51 | .03 | 0.00 | .03 | 4. | 1.01 | 12.35 | 151 | 0.00 | 0.00 | 0.00 | 61. |
| 1.01 | 4.20 | 52 | .03 | 0.00 | .03 | 4. | 1.01 | 12.40 | 152 | 0.00 | 0.00 | 0.00 | 59. |
| 1.01 | 4.25 | 53 | .03 | 0.00 | .03 | 4. | 1.01 | 12.45 | 153 | 0.00 | 0.00 | 0.00 | 56. |
| 1.01 | 4.30 | 54 | .03 | .01 | .02 | 4. | 1.01 | 12.50 | 154 | 0.00 | 0.00 | 0.00 | 54. |
| 1.01 | 4.35 | 55 | .04 | .03 | .01 | 4. | 1.01 | 12.55 | 155 | 0.00 | 0.00 | 0.00 | 51. |
| 1.01 | 4.40 | 56 | .04 | .03 | .01 | 5. | 1.01 | 13.00 | 156 | 0.00 | 0.00 | 0.00 | 49. |
| 1.01 | 4.45 | 57 | .04 | .03 | .01 | 6. | 1.01 | 13.05 | 157 | 0.00 | 0.00 | 0.00 | 46. |
| 1.01 | 4.50 | 58 | .04 | .03 | .01 | 8. | 1.01 | 13.10 | 158 | 0.00 | 0.00 | 0.00 | 43. |
| 1.01 | 4.55 | 59 | .04 | .03 | .01 | 12. | 1.01 | 13.15 | 159 | 0.00 | 0.00 | 0.00 | 41. |
| 1.01 | 5.00 | 60 | .04 | .03 | .01 | 16. | 1.01 | 13.20 | 160 | 0.00 | 0.00 | 0.00 | 38. |
| 1.01 | 5.05 | 61 | .07 | .06 | .01 | 22. | 1.01 | 13.25 | 161 | 0.00 | 0.00 | 0.00 | 35. |
| 1.01 | 5.10 | 62 | .07 | .06 | .01 | 29. | 1.01 | 13.30 | 162 | 0.00 | 0.00 | 0.00 | 33. |
| 1.01 | 5.15 | 63 | .07 | .06 | .01 | 39. | 1.01 | 13.35 | 163 | 0.00 | 0.00 | 0.00 | 30. |
| 1.01 | 5.20 | 64 | .07 | .06 | .01 | 51. | 1.01 | 13.40 | 164 | 0.00 | 0.00 | 0.00 | 28. |
| 1.01 | 5.25 | 65 | .07 | .06 | .01 | 65. | 1.01 | 13.45 | 165 | 0.00 | 0.00 | 0.00 | 25. |
| 1.01 | 5.30 | 66 | .07 | .06 | .01 | 80. | 1.01 | 13.50 | 166 | 0.00 | 0.00 | 0.00 | 23. |
| 1.01 | 5.35 | 67 | .10 | .09 | .01 | 98. | 1.01 | 13.55 | 167 | 0.00 | 0.00 | 0.00 | 21. |
| 1.01 | 5.40 | 68 | .10 | .09 | .01 | 118. | 1.01 | 14.00 | 168 | 0.00 | 0.00 | 0.00 | 19. |
| 1.01 | 5.45 | 69 | .10 | .09 | .01 | 140. | 1.01 | 14.05 | 169 | 0.00 | 0.00 | 0.00 | 18. |
| 1.01 | 5.50 | 70 | .10 | .09 | .01 | 164. | 1.01 | 14.10 | 170 | 0.00 | 0.00 | 0.00 | 16. |
| 1.01 | 5.55 | 71 | .42 | .41 | .01 | 193. | 1.01 | 14.15 | 171 | 0.00 | 0.00 | 0.00 | 15. |
| 1.01 | 6.00 | 72 | .76 | .75 | .01 | 229. | 1.01 | 14.20 | 172 | 0.00 | 0.00 | 0.00 | 14. |
| 1.01 | 6.05 | 73 | .42 | .41 | .01 | 275. | 1.01 | 14.25 | 173 | 0.00 | 0.00 | 0.00 | 13. |
| 1.01 | 6.10 | 74 | .24 | .23 | .01 | 330. | 1.01 | 14.30 | 174 | 0.00 | 0.00 | 0.00 | 12. |
| 1.01 | 6.15 | 75 | .23 | .22 | .01 | 393. | 1.01 | 14.35 | 175 | 0.00 | 0.00 | 0.00 | 11. |
| 1.01 | 6.20 | 76 | .10 | .09 | .01 | 464. | 1.01 | 14.40 | 176 | 0.00 | 0.00 | 0.00 | 11. |
| 1.01 | 6.25 | 77 | .10 | .09 | .01 | 545. | 1.01 | 14.45 | 177 | 0.00 | 0.00 | 0.00 | 10. |
| 1.01 | 6.30 | 78 | .10 | .09 | .01 | 633. | 1.01 | 14.50 | 178 | 0.00 | 0.00 | 0.00 | 9. |
| 1.01 | 6.35 | 79 | .07 | .06 | .01 | 730. | 1.01 | 14.55 | 179 | 0.00 | 0.00 | 0.00 | 9. |
| 1.01 | 6.40 | 80 | .07 | .06 | .01 | 833. | 1.01 | 15.00 | 180 | 0.00 | 0.00 | 0.00 | 8. |
| 1.01 | 6.45 | 81 | .07 | .06 | .01 | 934. | 1.01 | 15.05 | 181 | 0.00 | 0.00 | 0.00 | 8. |
| 1.01 | 6.50 | 82 | .07 | .06 | .01 | 1028. | 1.01 | 15.10 | 182 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 6.55 | 83 | .07 | .06 | .01 | 1111. | 1.01 | 15.15 | 183 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.00 | 84 | .07 | .06 | .01 | 1180. | 1.01 | 15.20 | 184 | 0.00 | 0.00 | 0.00 | 7. |
| 1.01 | 7.05 | 85 | .04 | .03 | .01 | 1232. | 1.01 | 15.25 | 185 | 0.00 | 0.00 | 0.00 | 6. |
| 1.01 | 7.10 | 86 | .04 | .03 | .01 | 1268. | 1.01 | 15.30 | 186 | 0.00 | 0.00 | 0.00 | 6. |
| 1.01 | 7.15 | 87 | .04 | .03 | .01 | 1290. | 1.01 | 15.35 | 187 | 0.00 | 0.00 | 0.00 | 6. |
| 1.01 | 7.20 | 88 | .04 | .03 | .01 | 1298. | 1.01 | 15.40 | 188 | 0.00 | 0.00 | 0.00 | 6. |
| 1.01 | 7.25 | 89 | .04 | .03 | .01 | 1295. | 1.01 | 15.45 | 189 | 0.00 | 0.00 | 0.00 | 5. |
| 1.01 | 7.30 | 90 | .04 | .03 | .01 | 1277. | 1.01 | 15.50 | 190 | 0.00 | 0.00 | 0.00 | 5. |
| 1.01 | 7.35 | 91 | .03 | .02 | .01 | 1251. | 1.01 | 15.55 | 191 | 0.00 | 0.00 | 0.00 | 5. |
| 1.01 | 7.40 | 92 | .03 | .02 | .01 | 1216. | 1.01 | 16.00 | 192 | 0.00 | 0.00 | 0.00 | 5. |
| 1.01 | 7.45 | 93 | .03 | .02 | .01 | 1175. | 1.01 | 16.05 | 193 | 0.00 | 0.00 | 0.00 | 5. |
| 1.01 | 7.50 | 94 | .03 | .02 | .01 | 1129. | 1.01 | 16.10 | 194 | 0.00 | 0.00 | 0.00 | 5. |
| 1.01 | 7.55 | 95 | .03 | .02 | .01 | 1079. | 1.01 | 16.15 | 195 | 0.00 | 0.00 | 0.00 | 5. |
| 1.01 | 8.00 | 96 | .03 | .02 | .01 | 1029. | 1.01 | 16.20 | 196 | 0.00 | 0.00 | 0.00 | 4. |
| 1.01 | 8.05 | 97 | .03 | .02 | .01 | 980. | 1.01 | 16.25 | 197 | 0.00 | 0.00 | 0.00 | 4. |
| 1.01 | 8.10 | 98 | .03 | .02 | .01 | 934. | 1.01 | 16.30 | 198 | 0.00 | 0.00 | 0.00 | 4. |
| 1.01 | 8.15 | 99 | .03 | .02 | .01 | 891. | 1.01 | 16.35 | 199 | 0.00 | 0.00 | 0.00 | 4. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 8.26 | 100 | .03 | .02 | .01 | 774. | 1.01 | 16.40 | 200 | 0.00 | 0.00 | 0.60 | 4. |

| | | | | |
|---|---|---|---|---|
| SUM | 6.10 | 4.34 | 1.75 | 41073. |
| | ( 155.)( | 110.)( | 45.)( | 1163.06) |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1299. | 537. | 285. | 285. | 41047. |
| CMS | 37. | 15. | 8. | 8. | 1162. |
| INCHES | | 4.16 | 4.42 | 4.42 | 4.42 |
| MM | | 105.72 | 112.25 | 112.25 | 112.25 |
| AC-FT | | 266. | 283. | 283. | 283. |
| THOUS CU M | | 328. | 349. | 349. | 349. |

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## COMBINE HYDROGRAPHS

COMBINE HIGHLAND LAKE OUTFLOW WITH LAKE WANDA INFLOW HYDROGRAPH

| ISTAO | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| A4 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

SUM OF 2 HYDROGRAPHS AT A4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. |
| 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. |
| 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. |
| 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. |
| 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. | 4. |
| 4. | 4. | 4. | 4. | 5. | 6. | 7. | 9. | 13. | 17. |
| 23. | 31. | 41. | 54. | 68. | 85. | 104. | 125. | 148. | 174. |
| 204. | 243. | 291. | 349. | 416. | 492. | 578. | 673. | 777. | 887. |
| 997. | 1099. | 1189. | 1265. | 1324. | 1366. | 1397. | 1421. | 1430. | 1424. |
| 1408. | 1383. | 1350. | 1309. | 1260. | 1204. | 1146. | 1089. | 1035. | 986. |
| 940. | 897. | 857. | 821. | 788. | 756. | 727. | 699. | 673. | 649. |
| 628. | 608. | 589. | 572. | 555. | 539. | 524. | 509. | 494. | 480. |
| 466. | 452. | 439. | 427. | 415. | 403. | 393. | 383. | 373. | 364. |
| 356. | 348. | 341. | 335. | 330. | 325. | 320. | 316. | 312. | 308. |
| 304. | 301. | 298. | 295. | 292. | 290. | 287. | 284. | 282. | 279. |
| 276. | 273. | 270. | 266. | 263. | 259. | 255. | 251. | 247. | 243. |
| 239. | 236. | 232. | 228. | 225. | 221. | 218. | 215. | 212. | 210. |
| 207. | 205. | 203. | 200. | 198. | 196. | 195. | 193. | 191. | 189. |
| 188. | 186. | 185. | 183. | 182. | 180. | 179. | 178. | 176. | 175. |
| 174. | 173. | 171. | 170. | 169. | 168. | 167. | 166. | 165. | 164. |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1430. | 715. | 325. | 325. | 64873. |
| CMS | 40. | 20. | 9. | 9. | 1840. |
| INCHES | | 1.91 | 2.41 | 2.41 | 2.41 |
| MM | | 48.52 | 61.27 | 61.27 | 61.27 |
| AC-FT | | 354. | 447. | 447. | 447. |
| THOUS CU M | | 437. | 552. | 552. | 552. |

ROUTE COMBINED INFLOW HYDROGRAPH THROUGH WANDA LAKE

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| A5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | 0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | 160. | -1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STAGE | 1173.90 | 1174.60 | 1174.80 | 1175.50 | 1175.80 | 1177.00 |
| FLOW | 0.00 | 16.00 | 28.00 | 118.00 | 276.00 | 1973.00 |
| CAPACITY= | 0. | 150. | 180. | 184. | 225. | 250. | 370. |
| ELEVATION= | 1169. | 1174. | 1175. | 1175. | 1176. | 1176. | 1177. |

| CREL | SPWID | COOW | EXPW | ELEVL | COOL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 1173.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COOD | EXPD | DAMWID |
|---|---|---|---|
| 1174.8 | 0.0 | 0.0 | 0. |

END-OF-PERIOD HYDROGRAPH ORDINATES

| MO.DA | HR.MN | PERIOD | HOURS | INFLOW | OUTFLOW | STORAGE | STAGE |
|---|---|---|---|---|---|---|---|
| 1.01 | .05 | 1 | .08 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .10 | 2 | .17 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .15 | 3 | .25 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .20 | 4 | .33 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .25 | 5 | .42 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .30 | 6 | .50 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .35 | 7 | .58 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .40 | 8 | .67 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .45 | 9 | .75 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .50 | 10 | .83 | 4. | 5. | 160. | 1174.1 |
| 1.01 | .55 | 11 | .92 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.00 | 12 | 1.00 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.05 | 13 | 1.08 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.10 | 14 | 1.17 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.15 | 15 | 1.25 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.20 | 16 | 1.33 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.25 | 17 | 1.42 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.30 | 18 | 1.50 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.35 | 19 | 1.58 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.40 | 20 | 1.67 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.45 | 21 | 1.75 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.50 | 22 | 1.83 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 1.55 | 23 | 1.92 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.00 | 24 | 2.00 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.05 | 25 | 2.08 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.10 | 26 | 2.17 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.15 | 27 | 2.25 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.20 | 28 | 2.33 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.25 | 29 | 2.42 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.30 | 30 | 2.50 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.35 | 31 | 2.58 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.40 | 32 | 2.67 | 4. | 5. | 160. | 1174.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.01 | 2.45 | 33 | 2. | 4 | 5. | 160. | 1174.1 |
| 1.01 | 2.50 | 34 | 2.83 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 2.55 | 35 | 2.92 | 4. | 5. | 160. | 1171.1 |
| 1.01 | 3.00 | 36 | 3.00 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.05 | 37 | 3.08 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.10 | 38 | 3.17 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.15 | 39 | 3.25 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.20 | 40 | 3.33 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.25 | 41 | 3.42 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.30 | 42 | 3.50 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.35 | 43 | 3.58 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.40 | 44 | 3.67 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.45 | 45 | 3.75 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.50 | 46 | 3.83 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 3.55 | 47 | 3.92 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 4.00 | 48 | 4.00 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 4.05 | 49 | 4.08 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 4.10 | 50 | 4.17 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 4.15 | 51 | 4.25 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 4.20 | 52 | 4.33 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 4.25 | 53 | 4.42 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 4.30 | 54 | 4.50 | 4. | 5. | 160. | 1174.1 |
| 1.01 | 4.35 | 55 | 4.58 | 5. | 5. | 160. | 1174.1 |
| 1.01 | 4.40 | 56 | 4.67 | 6. | 5. | 160. | 1174.1 |
| 1.01 | 4.45 | 57 | 4.75 | 7. | 5. | 160. | 1174.1 |
| 1.01 | 4.50 | 58 | 4.83 | 9. | 5. | 160. | 1174.1 |
| 1.01 | 4.55 | 59 | 4.92 | 13. | 5. | 160. | 1174.1 |
| 1.01 | 5.00 | 60 | 5.00 | 17. | 5. | 160. | 1174.1 |
| 1.01 | 5.05 | 61 | 5.08 | 23. | 5. | 160. | 1174.1 |
| 1.01 | 5.10 | 62 | 5.17 | 31. | 5. | 160. | 1174.1 |
| 1.01 | 5.15 | 63 | 5.25 | 41. | 5. | 160. | 1174.1 |
| 1.01 | 5.20 | 64 | 5.33 | 54. | 6. | 160. | 1174.1 |
| 1.01 | 5.25 | 65 | 5.42 | 68. | 6. | 161. | 1174.2 |
| 1.01 | 5.30 | 66 | 5.50 | 85. | 6. | 161. | 1174.2 |
| 1.01 | 5.35 | 67 | 5.58 | 104. | 6. | 162. | 1174.2 |
| 1.01 | 5.40 | 68 | 5.67 | 125. | 7. | 163. | 1174.2 |
| 1.01 | 5.45 | 69 | 5.75 | 148. | 7. | 164. | 1174.2 |
| 1.01 | 5.50 | 70 | 5.83 | 174. | 8. | 165. | 1174.2 |
| 1.01 | 5.55 | 71 | 5.92 | 204. | 8. | 166. | 1174.3 |
| 1.01 | 6.00 | 72 | 6.00 | 243. | 9. | 167. | 1174.3 |
| 1.01 | 6.05 | 73 | 6.08 | 291. | 10. | 169. | 1174.3 |
| 1.01 | 6.10 | 74 | 6.17 | 349. | 11. | 171. | 1174.4 |
| 1.01 | 6.15 | 75 | 6.25 | 416. | 13. | 174. | 1174.5 |
| 1.01 | 6.20 | 76 | 6.33 | 492. | 14. | 177. | 1174.5 |
| 1.01 | 6.25 | 77 | 6.42 | 578. | 17. | 180. | 1174.6 |
| 1.01 | 6.30 | 78 | 6.50 | 673. | 29. | 185. | 1174.8 |
| 1.01 | 6.35 | 79 | 6.58 | 777. | 40. | 189. | 1174.9 |
| 1.01 | 6.40 | 80 | 6.67 | 887. | 52. | 195. | 1175.0 |
| 1.01 | 6.45 | 81 | 6.75 | 997. | 65. | 201. | 1175.1 |
| 1.01 | 6.50 | 82 | 6.83 | 1099. | 80. | 208. | 1175.2 |
| 1.01 | 6.55 | 83 | 6.92 | 1189. | 96. | 215. | 1175.3 |
| 1.01 | 7.00 | 84 | 7.00 | 1265. | 113. | 223. | 1175.5 |
| 1.01 | 7.05 | 85 | 7.08 | 1324. | 153. | 231. | 1175.6 |
| 1.01 | 7.10 | 86 | 7.17 | 1366. | 204. | 239. | 1175.7 |
| 1.01 | 7.15 | 87 | 7.25 | 1397. | 254. | 247. | 1175.8 |
| 1.01 | 7.20 | 88 | 7.33 | 1421. | 335. | 254. | 1175.8 |
| 1.01 | 7.25 | 89 | 7.42 | 1430. | 437. | 261. | 1175.9 |
| 1.01 | 7.30 | 90 | 7.50 | 1424. | 529. | 268. | 1176.0 |
| 1.01 | 7.35 | 91 | 7.58 | 1408. | 611. | 274. | 1176.0 |
| 1.01 | 7.40 | 92 | 7.67 | 1383. | 684. | 279. | 1176.1 |
| 1.01 | 7.45 | 93 | 7.75 | 1350. | 747. | 283. | 1176.1 |
| 1.01 | 7.50 | 94 | 7.83 | 1309. | 801. | 287. | 1176.2 |
| 1.01 | 7.55 | 95 | 7.92 | 1260. | 846. | 290. | 1176.2 |
| 1.01 | 8.00 | 96 | 8.00 | 1204. | 882. | 293. | 1176.2 |
| 1.01 | 8.05 | 97 | 8.08 | 1146. | 909. | 295. | 1176.2 |
| 1.01 | 8.10 | 98 | 8.17 | 1089. | 929. | 296. | 1176.3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.01 | 8.15 | 99 | 8.25 | 1035. | 941. | 297. | 1176.3 |
| 1.01 | 8.20 | 100 | 8.33 | 986. | 947. | 297. | 1176.3 |
| 1.01 | 8.25 | 101 | 8.42 | 940. | 949. | 298. | 1176.3 |
| 1.01 | 8.30 | 102 | 8.50 | 897. | 946. | 297. | 1176.3 |
| 1.01 | 8.35 | 103 | 8.58 | 857. | 940. | 297. | 1176.3 |
| 1.01 | 8.40 | 104 | 8.67 | 821. | 930. | 296. | 1176.3 |
| 1.01 | 8.45 | 105 | 8.75 | 788. | 919. | 295. | 1176.3 |
| 1.01 | 8.50 | 106 | 8.83 | 756. | 905. | 294. | 1176.2 |
| 1.01 | 8.55 | 107 | 8.92 | 727. | 890. | 293. | 1176.2 |
| 1.01 | 9.00 | 108 | 9.00 | 699. | 873. | 292. | 1176.2 |
| 1.01 | 9.05 | 109 | 9.08 | 673. | 856. | 291. | 1176.2 |
| 1.01 | 9.10 | 110 | 9.17 | 649. | 838. | 290. | 1176.2 |
| 1.01 | 9.15 | 111 | 9.25 | 628. | 819. | 288. | 1176.2 |
| 1.01 | 9.20 | 112 | 9.33 | 608. | 801. | 287. | 1176.2 |
| 1.01 | 9.25 | 113 | 9.42 | 589. | 782. | 286. | 1176.2 |
| 1.01 | 9.30 | 114 | 9.50 | 572. | 763. | 284. | 1176.1 |
| 1.01 | 9.35 | 115 | 9.58 | 555. | 745. | 283. | 1176.1 |
| 1.01 | 9.40 | 116 | 9.67 | 539. | 726. | 282. | 1176.1 |
| 1.01 | 9.45 | 117 | 9.75 | 524. | 708. | 281. | 1176.1 |
| 1.01 | 9.50 | 118 | 9.83 | 509. | 691. | 279. | 1176.1 |
| 1.01 | 9.55 | 119 | 9.92 | 494. | 673. | 278. | 1176.1 |
| 1.01 | 10.00 | 120 | 10.00 | 480. | 656. | 277. | 1176.1 |
| 1.01 | 10.05 | 121 | 10.08 | 466. | 639. | 276. | 1176.1 |
| 1.01 | 10.10 | 122 | 10.17 | 452. | 622. | 274. | 1176.0 |
| 1.01 | 10.15 | 123 | 10.25 | 439. | 606. | 273. | 1176.0 |
| 1.01 | 10.20 | 124 | 10.33 | 427. | 590. | 272. | 1176.0 |
| 1.01 | 10.25 | 125 | 10.42 | 415. | 574. | 271. | 1176.0 |
| 1.01 | 10.30 | 126 | 10.50 | 403. | 559. | 270. | 1176.0 |
| 1.01 | 10.35 | 127 | 10.58 | 393. | 544. | 269. | 1176.0 |
| 1.01 | 10.40 | 128 | 10.67 | 383. | 529. | 268. | 1176.0 |
| 1.01 | 10.45 | 129 | 10.75 | 373. | 515. | 267. | 1176.0 |
| 1.01 | 10.50 | 130 | 10.83 | 364. | 502. | 266. | 1176.0 |
| 1.01 | 10.55 | 131 | 10.92 | 356. | 488. | 265. | 1176.0 |
| 1.01 | 11.00 | 132 | 11.00 | 348. | 476. | 264. | 1175.9 |
| 1.01 | 11.05 | 133 | 11.08 | 341. | 464. | 263. | 1175.9 |
| 1.01 | 11.10 | 134 | 11.17 | 335. | 452. | 262. | 1175.9 |
| 1.01 | 11.15 | 135 | 11.25 | 330. | 441. | 262. | 1175.9 |
| 1.01 | 11.20 | 136 | 11.33 | 325. | 430. | 261. | 1175.9 |
| 1.01 | 11.25 | 137 | 11.42 | 320. | 420. | 260. | 1175.9 |
| 1.01 | 11.30 | 138 | 11.50 | 316. | 411. | 260. | 1175.9 |
| 1.01 | 11.35 | 139 | 11.58 | 312. | 402. | 259. | 1175.9 |
| 1.01 | 11.40 | 140 | 11.67 | 308. | 393. | 258. | 1175.9 |
| 1.01 | 11.45 | 141 | 11.75 | 304. | 385. | 258. | 1175.9 |
| 1.01 | 11.50 | 142 | 11.83 | 301. | 377. | 257. | 1175.9 |
| 1.01 | 11.55 | 143 | 11.92 | 298. | 370. | 257. | 1175.9 |
| 1.01 | 12.00 | 144 | 12.00 | 295. | 363. | 256. | 1175.9 |
| 1.01 | 12.05 | 145 | 12.08 | 292. | 357. | 256. | 1175.9 |
| 1.01 | 12.10 | 146 | 12.17 | 290. | 351. | 255. | 1175.9 |
| 1.01 | 12.15 | 147 | 12.25 | 287. | 345. | 255. | 1175.8 |
| 1.01 | 12.20 | 148 | 12.33 | 284. | 340. | 254. | 1175.8 |
| 1.01 | 12.25 | 149 | 12.42 | 282. | 334. | 254. | 1175.8 |
| 1.01 | 12.30 | 150 | 12.50 | 279. | 329. | 254. | 1175.8 |
| 1.01 | 12.35 | 151 | 12.58 | 276. | 324. | 253. | 1175.8 |
| 1.01 | 12.40 | 152 | 12.67 | 273. | 320. | 253. | 1175.8 |
| 1.01 | 12.45 | 153 | 12.75 | 270. | 315. | 253. | 1175.8 |
| 1.01 | 12.50 | 154 | 12.83 | 266. | 311. | 252. | 1175.8 |
| 1.01 | 12.55 | 155 | 12.92 | 263. | 307. | 252. | 1175.8 |
| 1.01 | 13.00 | 156 | 13.00 | 259. | 302. | 252. | 1175.8 |
| 1.01 | 13.05 | 157 | 13.08 | 255. | 298. | 252. | 1175.8 |
| 1.01 | 13.10 | 158 | 13.17 | 251. | 294. | 251. | 1175.8 |
| 1.01 | 13.15 | 159 | 13.25 | 247. | 290. | 251. | 1175.8 |
| 1.01 | 13.20 | 160 | 13.33 | 243. | 286. | 251. | 1175.8 |
| 1.01 | 13.25 | 161 | 13.42 | 239. | 282. | 250. | 1175.8 |
| 1.01 | 13.30 | 162 | 13.50 | 236. | 277. | 250. | 1175.8 |
| 1.01 | 13.35 | 163 | 13.58 | 232. | 275. | 250. | 1175.8 |
| 1.01 | 13.40 | 164 | 13.67 | 228. | 273. | 250. | 1175.8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.01 | 13.45 | 165 | 13.75 | 225. | 271. | 249. | 1175.8 |
| 1.01 | 13.50 | 166 | 13.83 | 221. | 269. | 249. | 1175.8 |
| 1.01 | 13.55 | 167 | 13.92 | 218. | 267. | 249. | 1175.8 |
| 1.01 | 14.00 | 168 | 14.00 | 215. | 265. | 248. | 1175.8 |
| 1.01 | 14.05 | 169 | 14.08 | 212. | 263. | 248. | 1175.8 |
| 1.01 | 14.10 | 170 | 14.17 | 210. | 261. | 248. | 1175.8 |
| 1.01 | 14.15 | 171 | 14.25 | 207. | 259. | 247. | 1175.8 |
| 1.01 | 14.20 | 172 | 14.33 | 205. | 256. | 247. | 1175.8 |
| 1.01 | 14.25 | 173 | 14.42 | 203. | 254. | 247. | 1175.8 |
| 1.01 | 14.30 | 174 | 14.50 | 200. | 252. | 246. | 1175.8 |
| 1.01 | 14.35 | 175 | 14.58 | 198. | 250. | 246. | 1175.8 |
| 1.01 | 14.40 | 176 | 14.67 | 196. | 248. | 246. | 1175.7 |
| 1.01 | 14.45 | 177 | 14.75 | 195. | 246. | 245. | 1175.7 |
| 1.01 | 14.50 | 178 | 14.83 | 193. | 243. | 245. | 1175.7 |
| 1.01 | 14.55 | 179 | 14.92 | 191. | 241. | 245. | 1175.7 |
| 1.01 | 15.00 | 180 | 15.00 | 189. | 239. | 244. | 1175.7 |
| 1.01 | 15.05 | 181 | 15.08 | 188. | 237. | 244. | 1175.7 |
| 1.01 | 15.10 | 182 | 15.17 | 186. | 235. | 244. | 1175.7 |
| 1.01 | 15.15 | 183 | 15.25 | 185. | 233. | 243. | 1175.7 |
| 1.01 | 15.20 | 184 | 15.33 | 183. | 231. | 243. | 1175.7 |
| 1.01 | 15.25 | 185 | 15.42 | 182. | 229. | 243. | 1175.7 |
| 1.01 | 15.30 | 186 | 15.50 | 180. | 227. | 242. | 1175.7 |
| 1.01 | 15.35 | 187 | 15.58 | 179. | 225. | 242. | 1175.7 |
| 1.01 | 15.40 | 188 | 15.67 | 178. | 223. | 242. | 1175.7 |
| 1.01 | 15.45 | 189 | 15.75 | 176. | 221. | 241. | 1175.7 |
| 1.01 | 15.50 | 190 | 15.83 | 175. | 219. | 241. | 1175.7 |
| 1.01 | 15.55 | 191 | 15.92 | 174. | 217. | 241. | 1175.7 |
| 1.01 | 16.00 | 192 | 16.00 | 173. | 216. | 240. | 1175.7 |
| 1.01 | 16.05 | 193 | 16.08 | 171. | 214. | 240. | 1175.7 |
| 1.01 | 16.10 | 194 | 16.17 | 170. | 212. | 240. | 1175.7 |
| 1.01 | 16.15 | 195 | 16.25 | 169. | 210. | 240. | 1175.7 |
| 1.01 | 16.20 | 196 | 16.33 | 168. | 209. | 239. | 1175.7 |
| 1.01 | 16.25 | 197 | 16.42 | 167. | 207. | 239. | 1175.7 |
| 1.01 | 16.30 | 198 | 16.50 | 166. | 205. | 239. | 1175.7 |
| 1.01 | 16.35 | 199 | 16.58 | 165. | 204. | 239. | 1175.7 |
| 1.01 | 16.40 | 200 | 16.67 | 164. | 202. | 238. | 1175.7 |

PEAK OUTFLOW IS 949. AT TIME 8.42 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 949. | 588. | 268. | 268. | 53665. |
| CMS | 27. | 17. | 8. | 8. | 1520. |
| INCHES | | 1.57 | 1.99 | 1.99 | 1.99 |
| MM | | 39.94 | 50.61 | 50.61 | 50.61 |
| AC-FT | | 292. | 370. | 370. | 370. |
| THOUS CU M | | 360. | 456. | 456. | 456. |

********** ********** ********** ********** **********

1

RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

| | | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | AREA |
|---|---|---|---|---|---|---|
| HYDROGRAPH AT | A1 | 3798. | 1067. | 401. | 401. | 2.28 |
| | ( | 107.54)( | 30.22)( | 11.37)( | 11.37)( | 5.91) |
| ROUTED TO | A2 | 237. | 221. | 120. | 120. | 2.28 |
| | ( | 6.71)( | 6.27)( | 3.39)( | 3.39)( | 5.91) |

AD-A087 543 NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/13
NATIONAL DAM SAFETY PROGRAM. LAKE WANDA DAM (NJ00510), HUDSON R--ETC(U)
MAR 80 W A GUINAN DACW61-79-C-0011
UNCLASSIFIED NL

| | | | | | | |
|---|---|---|---|---|---|---|
| HYDROGRAPH AT | A3 | 1299. | 537. | 205. | 205. | 1.20 |
| | | ( 36.78)( | 15.20)( | 5.81)( | 5.81)( | 3.11) |
| 2-COMBINED | A4 | 1430. | 715. | 325. | 325. | 3.48 |
| | | ( 40.49)( | 20.24)( | 9.20)( | 9.20)( | 9.01) |
| ROUTED TO | A5 | 949. | 588. | 268. | 268. | 3.48 |
| | | ( 26.87)( | 16.66)( | 7.60)( | 7.60)( | 9.01) |

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1190.00 | 1190.00 | 1194.00 |
| STORAGE | 1850. | 1850. | 3199. |
| OUTFLOW | 0. | 0. | 1404. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 0.00 | 1191.42 | 0.00 | 2318. | 237. | 0.00 | 9.83 | 0.00 |

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1174.13 | 1173.90 | 1174.80 |
| STORAGE | 160. | 150. | 184. |
| OUTFLOW | 5. | 0. | 28. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 0.00 | 1176.28 | 1.48 | 298. | 949. | 10.25 | 8.42 | 0.00 |

APPENDIX 4

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